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No. 6. DECEMBER, 1902. Vol. I.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron & Steel, Mining, & Allied Industries.

DAVIDGE PAGE, Editor,

Clun House, Surrey Street, Strand, London, W.C.

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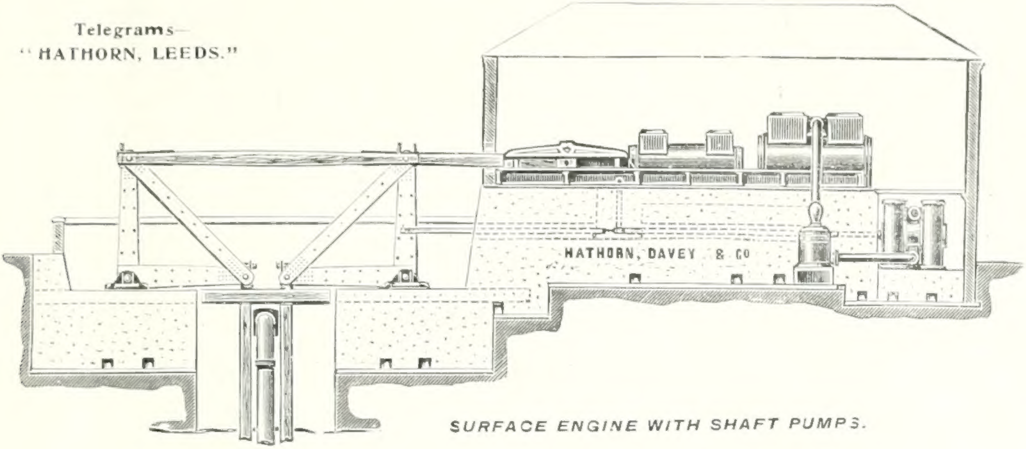

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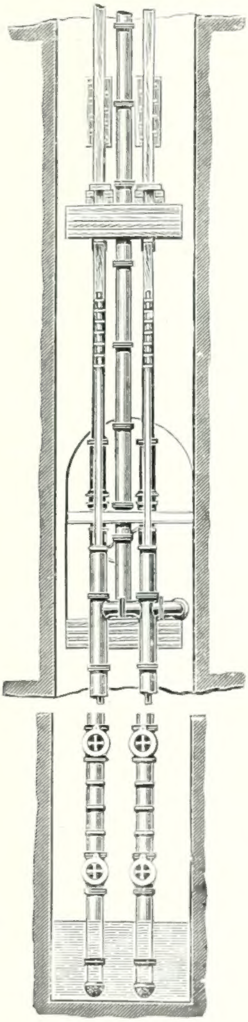

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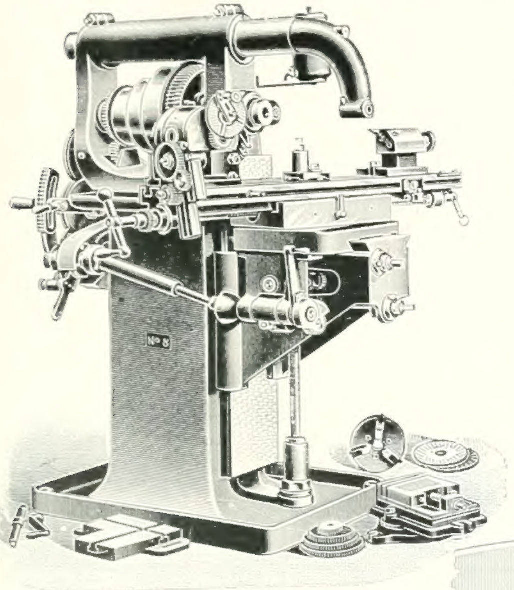

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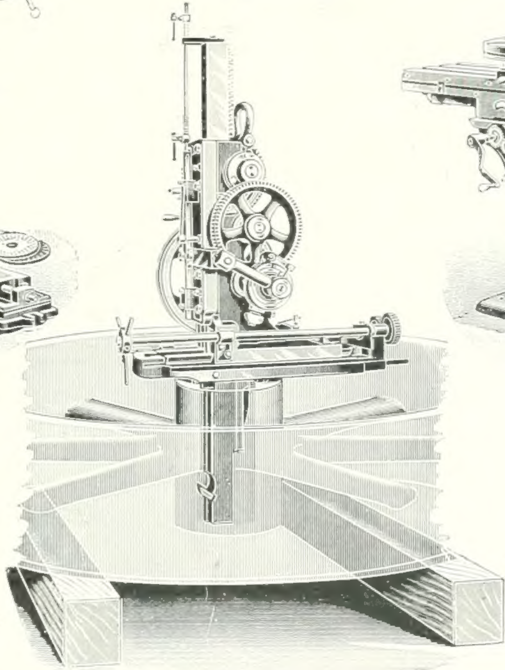

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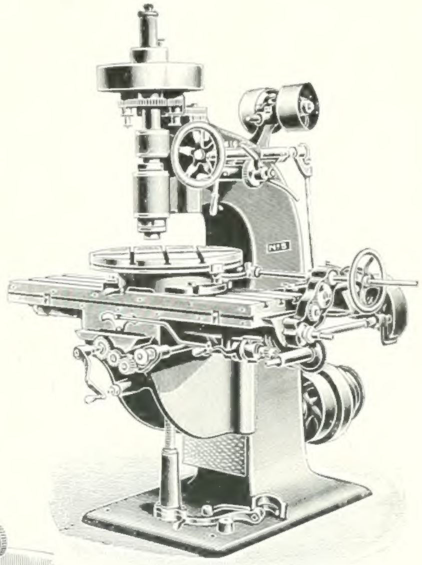

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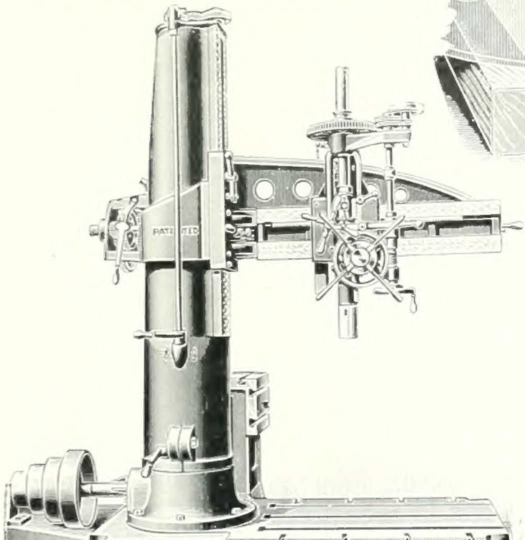

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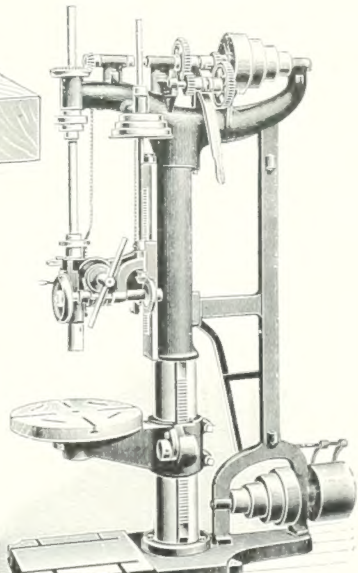

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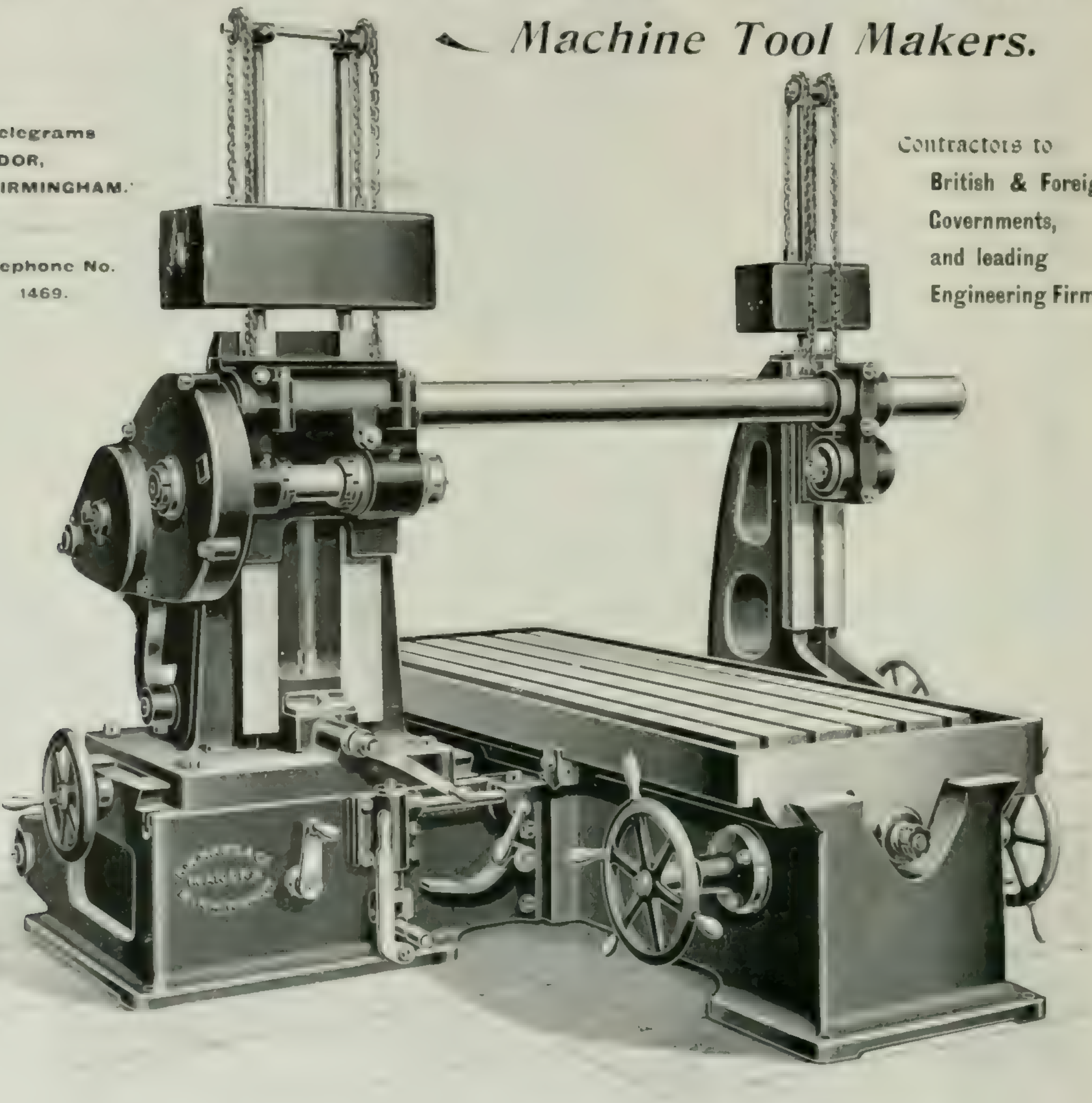

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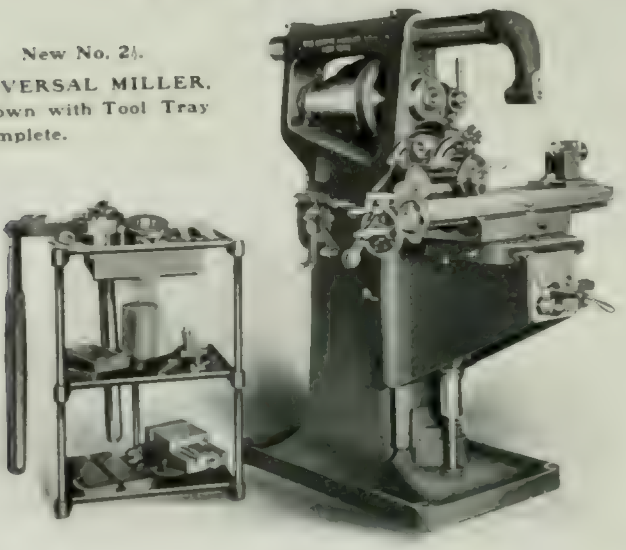

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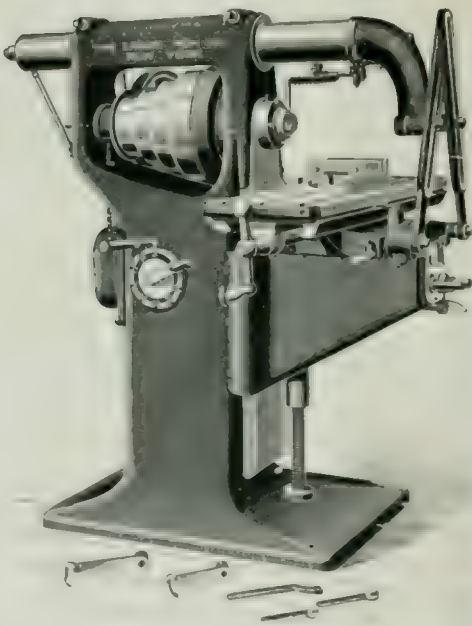

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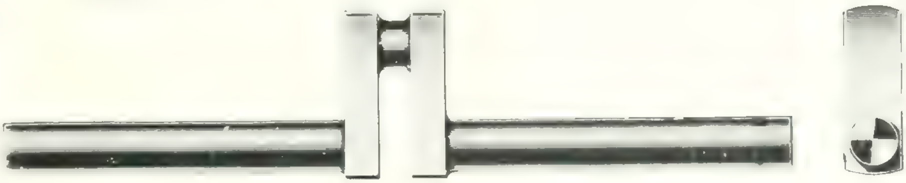

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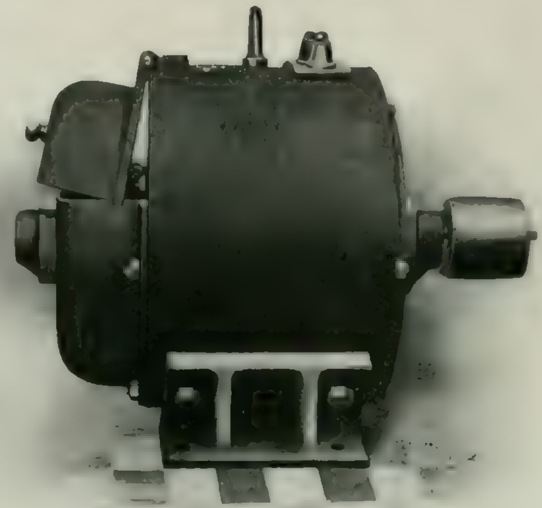

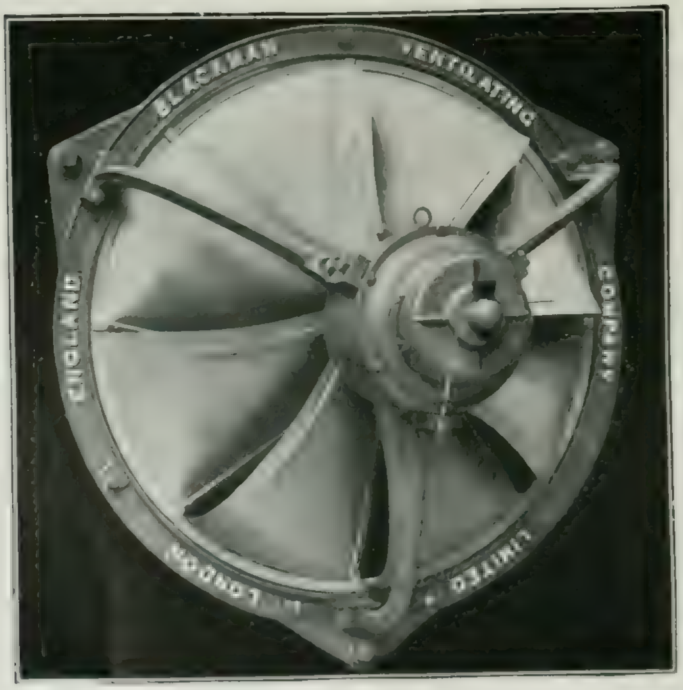
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PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining and Allied Industries.

VOL. I. LONDON, DECEMBER, 1902. NO. 6.

RAT ISLAND, PORTSMOUTH—THE SUGGESTED COALING POINT.

THE ROYAL DOCKYARD AT PORTSMOUTH.

BY

W. PRICE.

[illegible] not necessarily identify himself with the views of contributors.

A [illegible] controversial points are raised, and some of the [illegible] administration are here presented as they appear to the casual observer. Next month the matter will be [illegible] a local expert.—EDITOR.

IN view of the fact that the Royal dockyards cost the country millions every year, and are as necessary to the existence of the Navy as the Navy is to the existence of the Empire, it is astonishing that so little should be known about them by the nation, whose property they are.

A Royal dockyard is just a big engineering and shipbuilding establishment that is prevented by red tape from becoming as efficient at all points as the best of private yards are. It differs, too, from the latter in that the picturesque impress of the Navy is visible in every part of it. Of the various Royal dockyards, that at Portsmouth is the most important, though it is closely followed by Devonport and Chatham. From the days of Alfred the Great, Portsmouth has figured in naval history, but the present dockyard only dates back as far as Tudor times. In the reign of Henry VIII. the yard covered just eight acres; it now spreads over about 300 acres, and there is a likelihood of further extensions in the near future.

As one would expect in a place that has been centuries in developing, the ancient and

OVERCROWDING IN PORTSMOUTH DOCKYARD.
Old vessels awaiting purchase.

the modern exist cheek by jowl. In one place you can see dry docks, closed with gates and floored with stout oaken slabs, and a little further away some of the finest dry docks in the world. Altogether the yard contains 17 docks. No. 1 dates from 1340, and is 253 ft. 9 in. long, and 57 ft. 1 in. deep. Nos. 14 and 15, the most modern in the yard, are each 565 ft. 6 in. long, one of them is 94 ft., the other 82 ft. deep. These were built in order to accommodate the big four-funnelled cruisers that are now becoming so numerous in our fleet. Two other docks are also being considerably lengthened, because our warships have outgrown the accommodation provided for them. There are also six basins, having an aggregate area of 69½ acres, the largest basin being 22 acres in extent. Berthing room for a great many ships is provided alongside the jetties and in the harbour, and yet the dockyard is frequently overcrowded.

INADEQUATE ENGINEERING PLANT.

A good deal of space is given up to storehouses and workshops, and from an engineering point of view the latter form the most important section of the establishment. Even to-day the Admiralty does not always adopt a receptive attitude towards new ideas, and in the past its conservatism has often been adamantine. Proposed changes were regarded with disfavour because they would have been innovations; not because they were unnecessary. The Naval service, both ashore and afloat, suffered as a consequence. In time a more progressive generation came along, and wrought useful changes in the fleet; but still the dockyards were neglected. And even now in the workshops at Portsmouth and other similar establishments, there is to be found plant that no enterprising shipbuilder would think of retaining.

Taken as a whole, the engineering plant is somewhat antiquated and insufficient: it cannot cope with the demands made upon the establishment. It is a strange commentary upon Admiralty methods that our chief Naval dockyard is so poorly equipped with engineering machinery that the engines of a small cruiser cannot be built there without seriously interfering with the repairing and refitting work on other vessels. Yet that is

[illegible] UNDER THE GREAT STEAM DERRICK [illegible]

[illegible]

THE FLEET RESERVE AT PORTSMOUTH DOCKYARD.

These vessels are being disposed of by the Admiralty in order to make room for new ones.

how matters stand at present, as was proved by the delay in constructing the engines of H.M.S. *Pandora*, which are of only 7,000 i.h.p.

The Admiralty officials know the incapacity of the dockyards in this particular so well that the engines of our new warships are nearly all made by private contractors, even when the hulls are dockyard built. Undoubtedly there is much to be said in favour of allotting to private firms a good share of Government work; but that does not excuse the engineering deficiencies of our premier Naval yard. This establishment, like the ships attached to it, for manning and maintenance purposes, should be kept in a condition that would ensure its being in the highest possible state of efficiency if a war broke out. The yard, however, cannot be said to be kept up to this standard. Its engineering plant is insufficient for peace requirements, and it would be impossible to adequately meet the strenuous demands that war would make upon it. Such a condition of affairs, if allowed to continue, could, without exaggeration, be asserted to constitute a grave national danger.

It is only fair to the Admiralty to say that a certain quantity of new machinery has been purchased. But the shops have not been restocked with it to the extent they ought to have been' or to an extent that will secure as much efficiency as could be obtained in the space at present allotted to engineering plant.

A new steam factory is to be erected at an estimated cost of £188,000; but how much of this is to be spent on bricks and mortar and how much on machinery is not apparent. The building of a new workshop in a Royal dockyard is not always a move towards greater efficiency in the plant. Within the past few years a new boiler-making shop has been constructed at Portsmouth; but a good deal of old machinery was used in its equipment. It is to be hoped that this policy of building new stabling for old horses is not to be followed in the case of the new steam factory. In the estimates for the current financial year £7,000 is allowed towards the cost of the factory. This may, perhaps, mean that towards the end of the year the site will be laid out and the foundations excavated. Whether the remaining £181,000 will be provided next year, will depend upon whether the Admiralty wants the money for other purposes or not.

THE JAPANESE BATTLESHIP [illegible]

BASINS, ETC., PORTSMOUTH DOCKYARD, SHOWING SHIPS PREPARING FOR COMMISSION.

WHY IMPROVEMENTS ARE DELAYED.

One cause of the engineering deficiencies of Portsmouth dockyard is that the Navy and the Naval establishments are controlled mainly by sailors (the sea Lords of the Admiralty), who are prone to consider dockyard equipment as of secondary importance to the multiplication of ships. Another cause is the procrastinating methods of the Admiralty. If a private firm decides that it needs new machinery, it straightway gets it. But such business-like directness is impossible in the dockyards. First, the Admiralty has to be brought to recognise that the new machine is wanted; then the various departments concerned have to take the matter into consideration. Eventually the thing gets so far that it is put into the next year's estimates; and then the peculiar system of allocating expenditure operates to produce further delay. Instead of the required article being purchased outright, a certain sum of money is allowed towards the cost of it; a part of the work is done, and the remainder carried over till the next financial year. The block mills at Portsmouth afford a good illustration of the necessity for the renewal of much of the dockyard plant. The machinery in these mills was designed by the elder Brunel in 1801. At that time its construction was a big jump forward; but machinery a century old in design can hardly be considered as suitable for a modern industrial establishment. Some of the smithery appliances are also obsolete, and some of the docks are still emptied by chain pumps that have done service for many years past. Although Portsmouth is the principal Naval dockyard, it possesses only one building slip. This has been lengthened so that a vessel 500 ft. long can be laid down upon it.

SOME UP-TO-DATE APPLIANCES.

A step in the right direction, however, has latterly been made by the erection of a new smithery, and, more especially, in the laying down of a pneumatic tool plant for rivetting and drilling alongside the slip. These tools, which are of American pattern, are a most valuable addition to the dockyard, where all rivetting and drilling has hitherto been done by hand. Another important improvement is the introduction of what is reputed to be the most powerful set of steam derricks in the world.

VIEW IN PORTSMOUTH DOCKYARD.

Ships getting ready for sea, and torpedo-boats in dock.

These were erected about a year ago by Messrs. Cowans, Sheldon and Co., Ltd., of Carlisle, and have been tested to 150 tons. The illustration of these derricks is doubly interesting, as the ship lying beneath them is H.M.S. *Good Hope*, which has been requisitioned for Mr. Chamberlain's journey to South Africa. For the working of the capstans, the sliding caissons and some of the cranes, compressed air is generated at a central station and carried all over the yard. To a considerable extent the dockyard is built upon mudland that was reclaimed by convicts. But the wearers of the broad arrow are no longer employed as dockyard labourers, and the prison that housed them has been turned into electrical workshops.

ADMINISTRATION AND ORGANISATION.

So much for the engineering aspect of the dockyard; now a word as to administration. There are some 10,000 workmen employed at Portsmouth, and the wages bill is upwards of £14,000 weekly. This is exclusive of officials' salaries and the pay of the not inconsiderable number of men from the Naval Depôt who are employed about the yard in one capacity or another—mainly upon ships. The Commander-in-Chief, who is a full Admiral, has control over the ships commissioned and ready for commission, the Naval Depôt and the gunnery and torpedo schools. The dockyard proper is in the charge of a Rear-Admiral, denominated the Admiral-Superintendent, who receives in pay and allowances £1,883 per year, and is furnished with a residence. He also has a professional adviser called a civil assistant. This official, who is an ex-Chief Constructor, draws a salary of £1,000 a year. Other heads of departments—are the Chief Constructor, whose maximum salary is £850 a year; the Chief Engineer, who receives £750 a year, and is a naval officer; and the Director of Works, a Royal Engineer officer, who is paid £1,000 a year. The Staff Captain and King's Harbour-master, and captains of the dockyard and fleet reserves are not, strictly speaking, dockyard officials, though their duties lie within the yard and they have official residences there. Admiral-Superintendents are appointed for three years. Usually they are men who have spent the greater part of their lives at sea, and consequently their training has not perhaps been

of the kind that best fits a man to guide a big industrial concern. At present, however, Portsmouth possesses an Admiral-Superintendent who has good qualifications for his post. But past experience of this and other yards has demonstrated that though a man may be an excellent fleet-commander, he may not be suitably qualified for the post of Admiral-Superintendent. It can scarcely be expected that a system that often plumps round men into square holes can produce uniformly successful results. The best man to manage a shipyard is unquestionably the one who is specially fitted, by his training, for the post. A man who has spent the greater part of his life in learning seamanship, gunnery, etc., can hardly possess many qualifications for managing a big shore establishment. The complexities of dockyard organisation are difficult to understand. But there are, however, some good points about it, one of the best of which is

THE SYSTEM OF TRAINING MECHANICS.

The majority of people will, no doubt, be surprised to learn that there exists in the Royal dockyards a system of technical education that might advantageously be taken as a model by the country generally. No Cockerton judgments can interfere with it, and it has for years past given splendid results. Apprentices pass into the yard by examination, and, after getting in, have to attend the dockyard school for a period of three years. They thus get practical knowledge in the shops and theoretical instruction in the classes. In order to encourage the lads, the highest boys at the yearly examinations are made either engineer students at Keyham College or students of naval construction, as the case may be.

Sir E. J. Reed, Sir William White, Mr. Philip Watts, nearly all the Chief Constructors in the Royal dockyards, and many men who hold important positions under private firms, began life as apprentice boys at Portsmouth and other Royal dockyards, and owe their start in life to the teaching of the dockyard schools. This educational system furnishes the yards with highly skilled mechanics; and in order that the Government may have a hold upon them, a certain proportion of the men are "established"—that is, they become civil servants, and, as such, are entitled to pensions at the age of sixty. A good many of them must perforce remain at their tools, as opportunities for promotion are limited, and the only hope they have of earning extra money is by qualifying as divers. A good deal of diving work is done in the dockyards. Divers are wanted every time a ship is docked, and also for repairs to caissons, etc.

COALING FACILITIES.

One of the basins at Portsmouth is given up to ships in the A Division of the Fleet Reserve, vessels that are ready for commissioning. Close by these is the coaling point, which should store about 20,000 tons of coal. Usually a much larger quantity is laid there, and within recent years fires caused by overcrowding the storage space have given some trouble. To prevent a recurrence of these, and to provide more liberally for the demands of the ships, plans were prepared for the provision of a big coaling depôt. Rat Island, in Portsmouth Harbour, which is now used as a parade ground by the boys of H.M. training ship *St. Vincent*, was suggested as a suitable spot, but owing to the difficulty of finding good foundations for the piling, it seems probable that this scheme may be abandoned. In this event, some other must be devised in place of it, for the present coaling depôt is not only too small, but is also insufficiently equipped with transporting appliances. Only one big ship at a time can fill her bunkers alongside it.

In Portsmouth Harbour are many acres of mudbanks. The work of removing these in order to provide moorings for more ships is being steadily proceeded with. Every year some £5,300 is spent upon the dredging operations. But unless the rate of progress is accelerated, many years must elapse before the area of deep water is greatly extended. However, valuable anchorage space has been added to the port, which can now afford a haven for a considerable fleet.

THE COMMERCIAL DEVELOPMENT OF INVENTIONS.

JAMES SWINBURNE,

President of the Institution of Electrical Engineers, M.Inst.C.E., M.I.Mech.E.

ARGUMENT.--Conventionality and hatred of novelty—one reason for want of enterprise in England. Different ways of treating an invention. Finance in early stages. [illegible] Inertia and want of enterprise of moneyed men. The limited company and its evils. A typical inventor and his difficulties. His own industry will not have him. Outsiders ignorant. He gets up a syndicate. He gives up most of his interest. The syndicate gets short of money. Forming a large company. The ways of promoters. Indecision. Waste of time and money. Final flotation. Outrageous capital. Incompetent directors. Final catastrophe. What is wanted.

THE more unpractical of the political economists assume that a good thing will at once displace a bad one; and that a different manufacture, as good as an old product or better, and at the same time cheaper, will replace it forthwith. Such a theory as this is held only by people with a profound ignorance of human nature. We have all a great deal of the savage in us still, and one of the strongest characteristics of the savage is his hatred of the labour of adopting anything new. People dislike anything that involves bodily exertion, but they generally hate anything that involves thinking, and more especially anything like decision. Conventionality and custom are merely devices for saving people the trouble of thinking or deciding. In order to save us the trouble of deciding for ourselves, it is beneficently settled for us that we must wear clothes of a particular shape and colour, that our hats—in London, at any rate—must be cylinders of paste-board covered with the excretions of insects; that we must have open, smoky fires with a shelf over each, bearing three, five, or seven jars, or an even number of jars and a clock, that we shall eat off discs of silicate of alumina, and not off wood or metal; that we shall expose the tender legs and arms of babies to the weather; that we shall sleep half the day and sit up half the night; and so on through ninety-nine out of a hundred of the petty details of our existence. All this is to save us the pain of decision. In so far as it means economy of decision, so that we are more able to decide in other cases that come up, conventionality is a good thing; but to the extent that it saves decision altogether, it is merely keeping up our savage character. Extreme conventionality is conspicuous among savages, and among lower types generally. The schoolboy, being undeveloped, is much more conventional than the man, and woe betide the luckless youth who tries to do anything new or original at a public school. Next come women, and next to them comes the average man. Most men hate to have to arrive at any decision on anything, and loathe anything new that involves any change of mental attitude. The ordinary magistrate's hatred of the bicycle ten years ago, and the persecution of the motorist to-day, are due to savagery. The local opposition to electrical tramways, the objections raised to iron steamships and breech-loading guns in the Navy, and to anything modern in the Army, and generally to all improvements that involve change, are due to the same survival of savage instinct.

The unfortunate inventor is thus tremendously handicapped from the very beginning. Every-

thing seems to be against him in the early stages, when he is working out his crude idea, and the whole world is against him as soon as he tries to develop it commercially. The man of unapplied science has difficulty in getting a new theory understood, or a new discovery realised: but he has mainly to depend on other men of unapplied science for his reputation. At the very worst, if he can but publish a paper, he is secure, as it is only a matter of time. If he does not belong to the right scientific clique he may have his papers rejected by learned societies, or buried, as Waterston's was, or may meet with opposition, as in the case of young Helmholtz; but he only has to wait, and if he is right he gets his full reward. He has not to persuade capitalists or the public that his views are right. An inventor, on the other hand, must not only work out his theory, or make his discovery, which is as far as his colleague goes; but he has to work out details, get his invention into a practical shape, and get it taken up by the public. If he fails in any one of these matters, he reaps neither credit nor anything more solid; he might much better have left the whole thing alone.

WHY BRAINS AND MONEY DO NOT GO TOGETHER.

It has been said that some people have money and other people have brains. The obvious retort is that if the other people have brains they ought to get the money too. The proverb looks like the outcome of envy, and at first sight seems to have no foundation in fact. But it may be true all the same, and there may be a very good reason for it. Life is so short that it is very difficult for a poor man to become very rich, at any rate in this country. But the struggle which the poor man has to undertake excites the growth of his mental faculties, and though it may not give him any more new brains, it sharpens and trains what he has. The great man in nearly all walks of life has had a hard struggle when young, and he not only succeeds because he is a great man, but he is a great man largely because he has had to struggle in early years. But the unfortunate inventor, unless his invention is of some very peculiar kind, has to be financed, and is thus dependent on moneyed people for his start, and people who talk glibly about making fortunes by inventions have very little idea of the difficulties in the way of the inventor who wants capital.

We may consider the different types of people who finance inventions, and try and see the causes of the want of enterprise. We are told by the newspapers that the country is in a bad way because we are now devoid of enterprise. This is ascribed to many causes. Want of technical education is one reason given, and there may be a good deal in it. This cry is, however, also largely due to the technical science teacher, who wants to glorify his office; and until our technical school teachers are technologists with practical knowledge we shall not get any technical teaching, and while they are mere unpractical bookmen, who insist on trying to teach technology which they do not understand, instead of unapplied science, which they might more easily study, we must do without the teaching of first principles too. But there is something far deeper than any matter of technical education: there is a complete want of enterprise. Is it not because money, and therefore control of industry, is largely in the hands of the sons of the people who made it? A man in the busy part of last century, owing to a plucky struggle as a young fellow, develops a large manufacturing business. In due time his sons come into it. They have had an easy time as boys, and are only able to carry the business on. It takes little to carry on an established business; it will in a way go on, and even increase, of itself. If the sons work at their father's business they do so in a rather ineffectual way, but they are more likely to take no interest in it whatever. In England snobbery does us great harm industrially. We have still the idea that a gentleman is a man with no occupation. The ambition of the son of the cotton spinner or iron-master is to belong to the county. He therefore buys a house away from the town where his work is, and hunts and shoots, becomes a country magistrate, and believes it will be a bad time for the country when the good old sporting country gentleman dies out. Such a man as this puts any money he has to spare into various limited liability companies, which last a year or two and then retire to the *ewigkeit*. We will deal with limited companies presently.

THE LIMITED COMPANY.

Another type of man entirely is the City financier. He is keen enough in a way; but he knows nothing of industry, and he is only concerned with floating limited companies and selling out quickly. All he wants is to get shares which are rising and to sell them at a higher value. He does not concern himself in the least with industrial success.

The limited liability company was intended as a means by which all sorts of big enterprises might be taken up by small investors without danger. It was intended as a great blessing, but its results are quite the reverse. Most people who are wise do not live up to their incomes, and they want to invest the difference. There is no difficulty in finding a safe investment at low interest, but people think they can do better by investing in limited companies with glowing prospectuses, and as a rule they lose their money. But a man who loses his money in this way does not realise that he was a fool. He says: "Ah, well, it was only a flutter; better luck next time."

The limited company system is a colossal machine for getting rid of the savings of the nation in the most unsatisfactory way. Of course, many large undertakings have to be limited as to liability, but are otherwise worked on the same lines as private concerns. Their shares may be good investments, but they are generally bought by people who know, and do not go to the outsider. It never seems to occur to the ordinary speculator that if the shares in something he knows nothing about were valuable they would be bought by the people who do know about it, and they are only offered to outsiders because insiders will not have them. Investors in companies act like sheep. Some acquaintance makes some money out of a company because an even bigger fool buys the shares from him at an increased value. All his friends regard him as a sort of financial genius, and he becomes a bell-wether, and eventually, if cunning, he may develop into a director.

There are fashions in investment too. At one time Australian mines were the proper thing. It was the custom in Australia to float anything of little value in England. On one occasion a cable message from this country ran: "Stake out some mine directly; sold it for hundred thousand." The gold mine is the most popular, however; probably the average investor thinks gold is of necessity more valuable than copper, lead, or zinc. We are not, however, concerned with limited companies generally—that would be a very large subject. We need only discuss their relation to the inventor who needs financial assistance to develop a new industry.

THE INVENTOR'S POSITION.

We may take an imaginary inventor with a typical invention, and describe his experiences. We imagine the inventor to be a young and unknown man, who is well up in the technology of his subject, and we will assume he has discovered a new way of making white-lead. We will assume not only that he thinks he has made this discovery, but that he has actually discovered a way of making a pigment from lead which is cheaper than white-lead and better as to colour, covering power, and working with oil. He has made a few ounces with great difficulty at home, so he puts his sample in his pocket, and asks to see the proprietor of a white-lead works. He cannot get past a junior clerk, who takes his sample bottle and leaves it on a mantelpiece with little bottles of oil and other samples left by travellers. The oldest bottles have half an inch of dust on them, the others less in proportion. In a month he comes back, and sees his bottle where it was put, and finds nothing has been done. Probably he never gets past the junior clerk at all. But he tries many white-lead makers, and eventually gets to the proprietor. He is generally away shooting, or in the country, and only comes to the works once a month, and can spare very few minutes. He says: "I don't believe in artificial white-lead. It's been tried before, and is no use." This seems to him a conclusive argument. The inventor urges that he has studied the whole subject and knows exactly what has been done and what has not, and that his white-lead is all right. "But it is artificial, is it not? And if so, I tell you artificial white-lead has been tried before and won't do. Good-bye." This is as far as he is likely to get with a manufacturer. If he is very persistent the proprietor may say: "Well, I'll give your sample to my chemist to

try. I am not a technical man myself." The chemist probably analyses it, and has a preconceived theory that the goodness of white-lead varies directly or inversely as the hydrate present, it does not matter which, or he examines it with an oil-immersion objective, and if the particles are not of the shape he is accustomed to he will have none of it. He, therefore, reports against a new white-lead with an abnormal composition. He would report against it anyhow, because he does not really know, and if he reported a bad thing good he would get into difficulties, while in the reverse case nothing happens. He is prejudiced against anything new in any case, and sitting on someone else makes him feel superior. Moreover, if he let another man with technical knowledge into the works he might be ousted. However good the invention, it has no chance with the works chemist, or his analogue in other businesses.

It is hardly necessary to say that the white-lead maker and the inventor are entirely imaginary. The only whitel-ead maker I have known is remarkably keen about any invention or improvement that he can get hold of. White-lead is merely taken as a typical case.

It may be said that this view of a typical manufacturer is absurd; the proprietor of a works is far too eager and keen to let a good chance slip by. It must be remembered that he is not himself technical; that he has many supposed inventions brought him, and is quite unable to judge of them. In addition, taking up a new thing involves changes, and he would have to decide things, and there is nothing such a type of man hates more than having to decide anything.

The inventor therefore tries the paint merchants. They do not believe in artificial white-lead. One enterprising man may go so far as to say: "Send us a hundredweight, and we'll let our painters try it." Of course, the inventor cannot make a hundredweight. If he did, the painter would guess it was something new and report against it at once. No workman can stand anything new. Even if it were ever so much better he would oppose it.

The wretched inventor has thus no chance of getting his idea taken up by the proper people, that is to say, those already in the industry. He therefore turns to outsiders.

THE INVENTOR TRIES OUTSIDE HELP.

The first thing he wants is a few hundred pounds to try his invention on a larger scale. He cannot get at any big capitalist, because he is unknown and the affair appears too small. He has already wasted perhaps a year trying to get a hearing in the trade. He now hunts up various people, and at last gets the ear of someone, who is asked to put up £500 for a half share in the venture. He views the matter favourably, but cannot decide on such an important matter quickly. He has to be humoured. After six months of anxiety and disappointment, the inventor again gets an interview. "Oh, well, I thought you knew I'm taking up another matter, and I can't go into your affair now. Your scheme only offered a final profit of 30 per cent. on the capital; I have come across a young genius whose invention—a cheap way of making celluloid—promises much more than that. In the words of the claim it is: Treating shrimps with acetone, filtering off the shrimps, and evaporating the filtrate to recover the acetone, leaving the celluloid in blocks, substantially as described." "Have you ever tried that invention or consulted an expert?" "My inventor is a young genius; he knows it will work without trying it. I did ask an expert and he said shrimps' cases are not celluloid; but as he could not say what else they were, I don't believe he knows anything about the matter, and is prejudiced. My inventor does not know anything about theory, and is therefore independent of it. Celluloid is worth several shillings a pound, and the by-products being perfectly shelled are more valuable than the original shrimps, and will be sold for potting. Why, we can make a fortune from the by-products alone!" Who does not know the inventor with by-products!

The capitalist's relation with the engineer expert is also very curious. As a rule, a man will carefully avoid consulting an expert before investing. If he does come, he does not want your real opinion, he wants his own backed up. If you advise against the investment he is very much annoyed, and probably invests all the same. He thinks you are prejudiced, or that you are afraid to run the risk of recommending anything, in case of failure. On the other hand, if you recommend the investment, and make a

mistake in so doing, and the investor loses his money, he does not blame you. He treats you as a sort of brother in adversity, and recommends you to other people, and your practice thrives.

THE INVENTOR FORMS A SYNDICATE.

We will suppose, however, that in some way or another the inventor has got a few people to back him up, and has formed a syndicate with £1,000 available to try his invention on a larger scale. He has probably spent from one to two years in doing this, and has had to give away most of his interest in the invention, and has got much less money than he thinks necessary for the work. He probably under-estimates the cost anyhow, as even people with great experience of experimental work generally under-estimate the expense. The result is that the money is finished before the experiments are completed. The men who have put in the money will not put in any more. Each put in a hundred with the idea of getting ten thousand. He will let his hundred take its chance, but on no condition will he put in more. The inventor has given away so much of his own interest that he has no further inducement to offer. Nine good inventions out of ten are lost at this point. No new men will come in, for they say: "If your own people won't find you the money, there must be something wrong." The idea of getting the process examined technically is out of the question.

But we will suppose this particular inventor to be more fortunate than most, and that he has succeeded in getting as much money as necessary. It is probably a larger sum than need be, because his financial friends will have taken months and months to consider the question of finding more money, so that the works have been going on in an inefficient and expensive way. But in spite of that we will suppose he has spent ten thousand or so on his works, and has made several tons of very good white-lead, but the works being purely experimental, and very small, cannot be run on a paying scale. Now comes the most difficult time of all. He has to get a company formed large enough to make white-lead commercially on a paying scale. This needs, let us say, some £50,000 available in cash.

I must again repeat that I have no particular individual inventor in my eye. The case is typical only. The only white-lead inventor I know about did not get so far as this. An investor, as a rule, not only wants good terms, but he will not come in unless he gets better terms than all the previous investors. The inventor, as far as I understand the matter, not only gave away his whole interest, but in his anxiety gave away some of it twice by mistake. The result is a deadlock, and he is doing other work. His white-lead may be very good indeed—I do not know—but he, and probably no one else, will ever get anything out of it.

EXPERIENCE WITH FINANCIERS.

The inventor's financial friends are probably not in the swim as company promoters. They are small capitalists who have gone as far as they care to, and now expect other people to sow and grow their harvest for them. He approaches a financial house. With great difficulty he gets at one of the partners, who knows nothing about white-lead, and cares less, for he has nothing to do with the final commercial results. If he can form a company which the public will take up, so that he gets his money at once, he will be willing to do so. He must have special terms himself. This means that the syndicate gets practically nothing, and the inventor a small share of that. He will discuss it with his financial friends. After a few months, during which the inventor worries the financier at intervals, the financier says he cannot take the matter up. The inventor tries another house. After much delay he sees one of the principals, who says: "No. I lost money over a process once, so I am not going in for any more processes. If you had a mine, or a wireless telephone, or a submarine passenger steamer, or something striking, I could deal with you."

By this time his process will have been "hawked about," as it is called. This is one of the most mysterious disqualifications. If a financier hears of anything from more than one quarter, he condemns it off-hand on the ground that it has been hawked about. It is very difficult to see why. Every financier wants special terms, and unless he can get in on what he considers better terms than other financiers, he will not go in. If other financiers have had the

opportunity of going in, he has no special chance. Neither will he set his judgment up against that of the earlier financier. As a matter of fact, neither has any judgment to set up, for they know nothing technically, and merely estimate the chance of shoving a company on the public. Meantime the syndicate is getting into greater and greater difficulties owing to the delay. The City men say the Money Market is down, or South Africans are doing something eccentric. At this stage some people probably offer to take the matter up, and want a free option for, say, two months. They do nothing at all, but hope that in two months the syndicate will be glad to accept anything. At the end of the two months they offer a loan of £500 for a four-fifths share or something equivalent. The financiers' delay is no doubt generally due to pure indecision and want of grit, but it is also sometimes tinged with questionable integrity.

It will generally be found that the financial circles really are circles. A white-lead process will always come round eventually to one or two men who act as a sort of bell-wethers. They have made money out of some other process perhaps. When they invest, the sheep all follow, so the whole success of the process really depends on them. They probably do not know the difference between white-lead and black-lead, but they have the reputation of "knowing a good thing when they see it."

At this stage the inventor and his friends have probably spent several years and several thousand pounds. They have a process which is good and valuable, and worth a great deal of money; but they are totally unable to get it considered seriously. Probably no expert has examined it on behalf of any investors, because they have not got so far as that. The whole thing stands condemned because it promised no ridiculous profits, and because those directly interested in it are too inert and unenterprising, while the City man regards it as gone stale. What generally happens at this stage is that the whole thing collapses, and the patents are allowed to drop. Then the process is taken up in Germany or America, without any payment of royalty, and worked commercially, and the papers say we want protection, and the science teachers, who never invented anything, say we want technical education.

HE GETS A COMPANY FORMED.

But suppose they really induce a financial house to form a company. The procedure is complicated and mysterious, and only a specialist in company formation could say exactly what happens. First we will suppose £50,000 in cash is needed to put up the works. An ordinary person would say that if the syndicate were to have a half share the capital should be £100,000, half of this being paper. Nothing of the sort! The capital will be about £300,000, and the syndicate will not get half, nor anything like it, and the inventor may get what chemists call a "trace." Out of the £300,000 probably half will be issued for cash. Where it all goes to is a mystery to the outsider, but there are various calls. In the first place the promoter will not go on unless the shares are underwritten. The underwriters want a good deal for their risk, for if the issue is not taken up their money is locked up for some years. It does not matter whether the process is good or the company eventually pays. They must either have their money locked up and unavailable, or they must sell out low. Even if the invention is good and everything right they are dependent entirely on the fancies of a perfectly ignorant and sheep-like investing public. If one paper runs the issue down, all the sheep will turn aside, and the underwriters will be left with all the shares. The prospectus is generally issued and the dates fixed so that the technical papers, which are weeklies, cannot criticise. It is impossible to bribe technical papers. Of course, it is absolutely impossible to bribe or affect financial papers in any sort of way too. But people who watch the relations of the interior opinions to prospectus advertisements, and people who buy large numbers of copies of financial papers containing accounts of their public meetings, and people who have to give away shares to gentlemen whose part in the proceedings is vague, sometimes get a false impression as to the immaculateness of our noble financial press. If the new company has plenty of promoters' shares it is a coincidence that it will be praised up as an investment in the right quarters, and has nothing to fear. But with the technical press it is different. It cares nothing for prospectus advertisements, and is run by a class of people who acquire any

shares they ever want by purchase for cash. The promoters thus fear the technical press. The technical press considers, not whether the shares are going to a premium the day after to-morrow, but whether the company is financially sound, and can eventually pay dividends. The promoter of the sound company is just as much afraid of the technical press as any other promoter. How does he know his company is sound? That has nothing to do with him, and is outside his ken altogether. He has therefore to risk the technical papers. Sometimes the technical papers condemn a good thing, as a technical editor has to be omniscient, and has to form an opinion with few data, and he is more likely to condemn a good thing than to praise a bad one. Be that as it may, the lists are always arranged to close on Thursday, while the technical papers come out on Friday.

In order to make the issue go down, the promoters not only need underwriters, they need directors. A board of incompetent amateurs is necessary, preferably with a few titled names and some retired soldiers. Then the brokers require a big fee for the appearance of their names. A consulting chemist is needed, and a report from some entirely non-technical professor with a string of letters after his name is published. He has probably never been inside a white-lead works, and has no idea of the costs of manufacture, on which everthing depends. Then the patents have to be submitted to counsel. Counsel says they are valid, but does not say whether they really cover the process, or whether they can be perfectly easily circumvented. In this case we will suppose the patents are valid, and protect the proprietors. Then the company is finally launched on the guileless public, and thousands of people in all walks of life, with all possible varieties of ignorance about white-lead, take shares, and the peers and retired generals proceed to wreck the whole affair by gross and idiotic mismanagement, and in three years the inventor, with a ruined reputation, seeks a minor appointment in a works where they use the good old Dutch process.

WHAT IS WANTED.

What is wanted is a strong financial concern which will develop inventions on terms that are fair to both parties. Such a concern should never put a large proportion of its capital into any one thing, and it should be advised by competent specialists as to both technical and financial questions. The experts should be technologists, not unpractical people, and should hold shares in the concern. Such a house could make terms with an inventor at any stage of the development of his invention. At first the inventor has generally inflated ideas, but they always cool down in contact with financial difficulties. Such a concern as this, managed on business lines by really technical business people, would develop enormous industries, and make an immense amount of money; but it would have to be managed by people who had enterprise, were not led like sheep by City opinion, decided quickly, dealt honourably, and were technical business men.

PROFESSOR JOHN GOODMAN, M.Inst.C.E., M.I.Mech.E.,

Professor of Engineering, Yorkshire College, Leeds.

PROFESSOR GOODMAN, unlike so many who hold similar positions, had a very thorough practical engineering training. He served two years at fitting and turning in the Progress Iron Works, Bassingbourn, Cambs., and three and a half years at erecting, turning, fitting, pattern-making, and foundry work in the Globe Works, Northampton. As assistant to the late Mr. Stroudley, in the locomotive works of the L.B. and S.C. Railway, at Brighton, he carried out a large number of tests on the friction of bearings, the strength of crank shafts and axles; also the testing of locomotives. While there he obtained a Whitworth Scholarship, and afterwards went to the University College, London, to study the scientific side of engineering. After further experience as assistant to Professor Kennedy, F.R.S., in his Westminster office, he took a temporary post on the staff of *Engineering*. Following that appointment, he was for two years chief assistant to Mr. W. H. Stanger, of the Broadway Testing Works, Westminster.

In the autumn of 1899 he was appointed the Professor of Engineering in the Yorkshire College, Leeds, a post which he still holds. During his tenure of the chair, the engineering department has flourished in every respect. The numbers have increased threefold, and the laboratories have been enlarged, and much new plant has been added; in fact, it is now one of the most successful and best equipped engineering colleges in the country. He is the author of several papers on friction, for which he was awarded a Miller Prize and a Miller Scholarship by the Institution of Civil Engineers. He is also the author of many short papers, and his well-known book, "Mechanics Applied to Engineering," is used in many English and American colleges.

THE TRAINING OF PROFESSIONAL ENGINEERS.

By

PROFESSOR JOHN GOODMAN, M.INST.C.E.

As Professor of Engineering at the Yorkshire College, Leeds, the author has had exceptional facilities for watching the careers of some hundreds of young engineers, and his very practical remarks should prove of considerable interest to those who contemplate embarking upon engineering as a profession.—EDITOR.

THAT a young professional engineer requires a special training to fit him for his future work probably none will deny; but as to what course that training should take there appears to be a great diversity of opinion. As one who has advised and carefully watched the careers of some hundreds of young engineers, the writer trusts that his opinions upon this matter may afford some guide to those who contemplate the starting of their sons upon an engineering career.

The writer has always made a great point of keeping in touch with his former pupils, in order to watch their progress in the profession, and to enable him to study carefully the effect that their technical training has had upon them. This friendly intercourse between a professor and his former pupils cannot be other than mutually beneficial: and, as far as the writer is concerned, he has, moreover, found it to be one of the most pleasant experiences of an interesting and absorbing profession.

The head of a large and important engineering department is frequently called upon to advise parents and schoolmasters as to the wisdom, or otherwise, of certain lads taking up engineering as a profession. In such cases the writer usually puts a few test questions in order to discover, if possible, whether the lad has a reasonable chance of success at engineering, such questions being somewhat on the following lines: (1) Is the youth tolerably robust, and if not, has a medical man been consulted as to the probability of his being able to stand the rough practical work that is absolutely essential to every engineer? If this cannot be satisfactorily answered, a decided opinion is expressed that engineering should not be chosen by him as a profession, for if an earnest youth makes an honest attempt to do his duty in the works it will make considerable demands on his physical strength. (2) Is he really keen about engineering, and does he intend to stick to it in spite of hard, dirty work, and possibly a large amount of drudgery for some years to come, and is he determined to succeed at all costs? If a youth is not quite sure whether he will like engineering or not, and wants to know if he may wear gloves in the shops and whether he need start work before breakfast, etc., etc., it is a sure and unmistakable sign that he is not made of the sort of stuff that engineers are made of, and the sooner he decides upon a trade or profession that does not demand manly qualities the better for all parties concerned. (3) Has he done reasonably well at school, especially in mathematics and mechanics, and is he of a studious turn of mind?

In the writer's opinion a youth cannot hope for success in the higher branches of the profession unless this last question can be answered satisfactorily.

As regards his school training, he ought to get a thoroughly good general education, such as is given in most of our public schools. It is probably not well to specialise in the school

training to any great extent, but in the higher forms modern languages may advantageously be taken in preference to Latin and Greek. In mathematics, as a minimum, he should be familiar with the first three books of Euclid, or the subjects thereof, as taught in some modern text-book on geometry; also arithmetic and algebra up to quadratic equations. A knowledge of elementary mechanics, physics, and chemistry is desirable, also freehand and geometrical drawing.

The school workshops in many public schools do valuable work by giving youths a good idea of the use of tools; but, of course, they cannot possibly give a sufficient training to enable them to dispense with the practical training in engineering works.

In the case of those youths who intend to take up a university degree course, higher standards than those mentioned above are necessary.

AGE AT LEAVING SCHOOL.

It is impossible to draw a hard and fast line as to when a youth intending to become an engineer should leave school, but it should certainly not be under sixteen, and only in rare instances should it be over eighteen.

ENGINEERING TRAINING.

In the case of civil engineering students, we believe that the college training may be taken immediately after leaving school. But, in the case of mechanical and electrical students, there is a great difference of opinion as to the best order of training; the chief point of contention being—whether the works should precede the college training, or *vice versâ*. We think it will be well to state the arguments advanced by both sides. They are:—

In Favour of the Works Training Preceding the College Training.

Students who have not gained some practical experience in works cannot take full advantage of the college course on account of their ignorance of machinery and manufacturing processes. The works training is to a large extent a question of acquiring manipulative skill; hence it is better for such training to be taken while young, say, at sixteen or seventeen, rather than three or four years later.

It is much more distasteful to a student to commence the inevitable rough and dirty work in the workshops at, say, twenty years of age than at sixteen.

The scientific side of engineering is the more difficult to acquire; hence it is better that it should be taken up when the student is somewhat matured, rather than when he is fresh from school.

Youths often take up engineering as a mere fancy, and do not discover that they are unsuited for it until they have to "rough it" somewhat in works; hence, if they go into works first they much more quickly come to a decision, and consequently waste less time than if a college course intervenes.

Many proprietors of works and heads of firms object to taking youths into their works as pupils or apprentices at the age when most students leave college.

In Favour of the College Training Preceding the Works Training.

Youths make more rapid progress in practical work after having taken a college course than when they enter works straight from school. The college training teaches them how to learn and how to observe; consequently, when they get into work they pick up the practical side of the work much more rapidly than the novice who comes straight from school.

If a youth leaves the works in which he has spent, say, four or five years, in order to go to college, he breaks his connection with the firm just at a time when he is most valuable. He thereby gets out of touch with his firm, and may lose the chance of promotion with them; and, moreover, it rarely happens that a young fellow of, say, one or two-and-twenty cares to throw up remunerative work for two or three years in order to go to college—the result being that he misses his college training altogether.

A youth coming fresh from school is in the habit of acquiring knowledge, and has all his mathematical and elementary science fresh in his mind; consequently, he has a far better chance of making headway at college than the youth who has allowed his school-work to get rusty.

The writer's experience leads him to believe that there is much force in many of the

arguments advanced by both sides; therefore, after very careful consideration, he has come to the conclusion that in the case of mechanical and electrical engineers, the best course to adopt is a compromise between the two.

COURSE OF TRAINING RECOMMENDED.

After receiving a good education, it is recommended that (1) a youth should be sent to some small general engineering works, where he is more likely to get a useful experience than in a larger establishment, for about twelve or eighteen months; (2) he should take either a two or a three years' course of instruction in a college, and during this time he should pass the qualifying examination for admission to the Institution of Civil Engineers; (3) he should go into some larger engineering works where he can specialise in some particular branch for a period of not less than two years; (4) he should go into the drawing office for at least one year. And, if possible, he should visit, or, better, spend a year or two in engineering works in the United States, where he will be able to earn sufficient to keep him and will gain most valuable experience. Such a course of training will thus take from six to seven years, which in some instances may be more time than many parents can afford to give their sons. In such cases, the expense of the college course may be materially reduced by scholarships; but this, of course, entirely depends upon the ability and diligence of the student. Then, again, if youths do well, they will nearly always receive some remuneration during the stages 3 and 4 mentioned above.

It should, however, always be borne in mind that the more thorough the training the higher will be the position ultimately attained, of course, assuming suitable material to work upon.

WHILE IN WORKS.

The writer would urge parents to put pressure on their sons to keep the regular and full shop hours, and not to allow them to commence work after breakfast: if a youth is not willing to make this sacrifice, he does not possess the necessary "grit" to make an engineer.

In order that a student may not allow his school work to get rusty, it is advisable that he should attend evening classes at a college for, say, two evenings a week, in such subjects as mathematics, mechanics, or drawing; but it is not recommended that more time than this should be devoted to evening study.

NECESSITY FOR WORKS TRAINING.

Parents often send their sons to institutions on account of the so-called "practical" instruction in shop processes which is given in their workshops, under the delusion that such a course of instruction will give a lad all the practical experience that he requires, and that he will thereby be saved the "dirty" work in engineering works. This, however, is a deplorable blunder, and if persisted in the lad will sooner or later find himself hopelessly incompetent to hold any important position as an engineer. The writer has seen so many instances of failure of young men who, although otherwise promising, imagined that they acquired sufficient practical knowledge of engineering when they were in the school and college workshops, but when they got out into the world were found to be sadly incompetent from a practical point of view, that he feels he cannot too strongly advise parents to avoid the mistake of fostering the idea that there is any such "royal road" to engineering. The fault does not lie with such workshops, but in the idea that they alone can give a sufficient practical training. The writer's experience, however, leads him to believe that the experimental work done in college engineering laboratories is of the greatest possible value to engineers, and that the college laboratory can do what cannot be done in the works, and that the works can do what cannot be done in a laboratory; both are regarded as indispensable, but each should do that which it is able to do thoroughly, and not spoil both by attempting to combine them in one and the same place.

TORPEDO-BOAT DESTROYERS—A CONTRAST.

H.M.S. *Havock*, the earliest destroyer (in foreground), and the new turbine vessel, H.M.S. *Velox* (behind).

COLONEL McCALMONT'S STEAM YACHT "TARANTULA."

FORTHCOMING DEVELOPMENTS IN THE MARINE STEAM TURBINE.

BY

HERBERT C. FYFE.

At the present moment the British Government is the only nation in the world that possesses a turbine-propelled war-vessel. The new torpedo-boat destroyer *Velox* was purchased by the Admiralty a few weeks ago, and has proved itself to be the fastest destroyer afloat. We are enabled, by the courtesy of the Parsons Marine Steam Turbine Company, of Wallsend-on-Tyne, to reproduce here some photographs of this and other vessels fitted with this form of turbine—which is the invention of the Hon. C. A. Parsons, a brother of the Earl of Rosse.—EDITOR.

THE marine steam turbine may be expected to be developed along the following lines:—

1. In war ships.
2. In passenger steamers.
3. In pleasure yachts.

It may be convenient to consider these in the order mentioned.

STEAM TURBINES IN THE ROYAL NAVY.

In his "Statement Explanatory of the Navy Estimates, 1902-03," the Earl of Selborne made the following reference to turbine men of-war:—

The country has had to deplore the wrecks of H.M.S. *Viper* and *Cobra* during the past year, accompanied in the latter case by a lamentable loss of life. One result has been for the present to put a stop to our experiments with the turbine system of machinery, but the Board are negotiating for a renewal of the experiment in two more destroyers, and in one third-class cruiser.

In addition to the recently purchased *Velox*, the Admiralty will shortly possess another destroyer fitted with the marine steam turbine. It will be named the *Eden*, and has also been ordered from the Parsons Marine Steam Turbine Company. The hull is being constructed by Messrs. Hawthorn and Leslie, who were also responsible for the hull of H.M.S. *Velox*.

The third-class cruiser to be fitted with turbine machinery is H.M.S. *Amethyst*, one of two provided for in the Navy Estimates of 1901-02. The other, H.M.S. *Topaze*, will be fitted with reciprocating machinery of the ordinary type, and it will thus be possible to compare their speeds, coal consumption, economy, etc.

The French Government are believed to be experimenting with a view to determining the advisability of fitting some of the vessels of the French Navy with turbine engines, but so far as the writer is aware they have not up to the present purchased any ships so fitted.

H.M.S. *Velox* differs radically in constructive details from the *Turbinia*, the *Viper*, and the

H.M. TORPEDO-BOAT DESTROYER, "TURBINIA," STEAMING 40 KNOTS.

THE STEAM YACHT [illegible]

H.M. TORPEDO-BOAT-DESTROYER "VIPER" STEAMING AT FULL SPEED.

Cobra. The *Turbinia*, the first vessel to be fitted with the marine steam turbine, was merely an experimental craft. She was 100 ft. in length, 9 ft. beam, 3 ft. draught of hull, and 44 tons displacement. She was fitted with turbine engines of 2,000 actual h.p., and reached a speed of 34½ knots.

In 1898 the Parsons Marine Steam Turbine Company contracted with the Admiralty for a 31-knot torpedo-boat destroyer, the *Viper*, which was to be of the same dimensions as the usual 30-knot vessels of this class, viz., 210 ft. in length, 21 ft. beam, and about 370 tons displacement, but with machinery of much greater power than was usual in vessels of this size. At the same time they contracted with Sir W. G. Armstrong, Whitworth and Co., for machinery for one of their torpedo-boat destroyers, the *Cobra*.

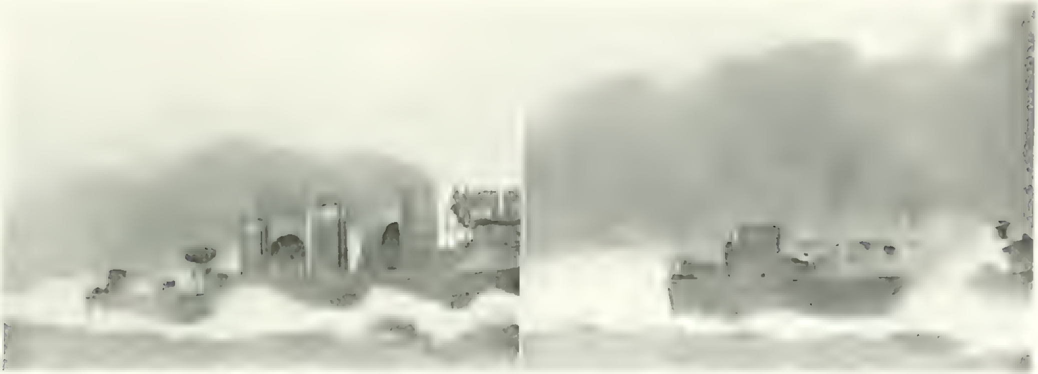
In his statement (dated 3rd March, 1898) for 1898-99, the First Lord of the Admiralty said that an order had just been placed for an experimental vessel, in which the steam turbine would be substituted for the ordinary reciprocating type of machinery in order to test the applicability of the system to torpedo vessels of exceptionally high speed.

The *Viper* was built by Messrs. Hawthorn, Leslie and Co., at Hebburn-on-Tyne, and was launched on September 6th, 1899. In his statement, dated February 17th, 1900, Viscount Goschen (then Mr. Goschen) said that the contract speed was 31 knots, but it was anticipated that a considerably higher speed would be attained; on preliminary trials (for short periods) speeds of about 35 knots had been reached. It was hoped that the vessel would soon be ready for her official trials, and when these were completed it was proposed to make exhaustive experiments with her, as great importance was then attached to this novel system of propulsion.

The *Viper* was 210 ft. long, 21 ft. beam, 12 ft. 9 in. deep, and her displacement was 350 tons. Her indicated h.p. was 16,000.

There were four propeller-shafts and two propellers on each, making eight in all, the revolutions being about 1,200 per minute.

In exterior appearance the *Viper* did not materially differ from the ordinary torpedo-



H.M. TORPEDO-BOAT DESTROYER "VIPER" STEAMING AT FULL SPEED.

boat destroyer, except that her funnels were of much greater diameter; but down below the difference was at once manifest.

THE ENGINES OF THE "VIPER."

The interest in the vessel, as an engineer has remarked, is centred in the engine-room.

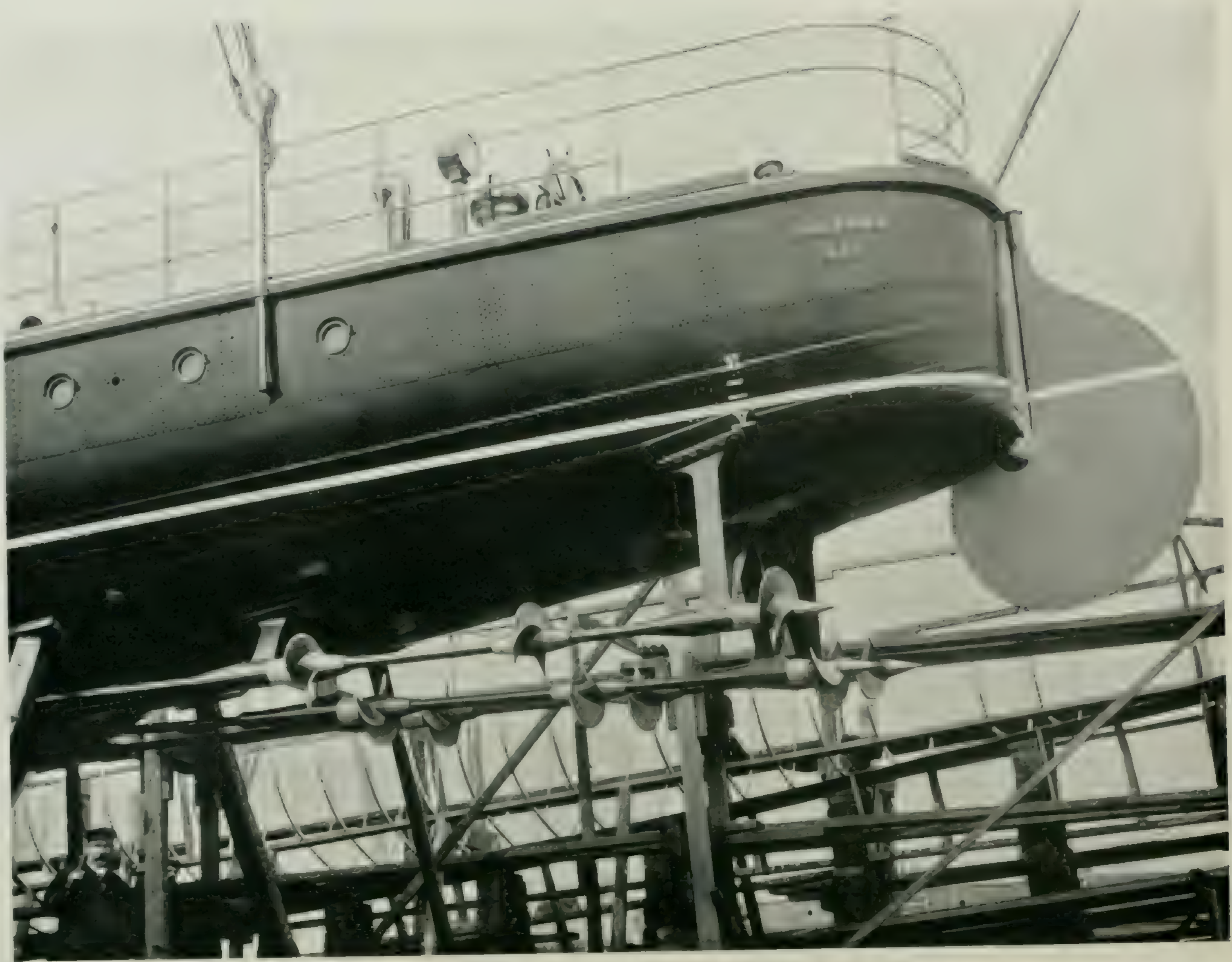
Here [illegible] quite different to the familiar double row of twin-screw engines, with their four cylinders [illegible] the passage from end to end. In place of this, one descends on to a platform stretching right athwart ships, where are the large stop valves which control the flow of steam to the turbines, by which alone the engines are manœuvred; for there is naturally no valve motion, or, for that matter, no engine valves, nor any reversing gear. Beneath the platform is placed a good half of the engine, that is to say, the part which corresponds to the high-pressure cylinders of an ordinary compound engine. These turbines are, in fact, quite invisible, being stowed away under the floor, and need no attention whether running or standing. A little further aft are to be seen in the bottom of the vessel the larger low-pressure turbines, but the most conspicuous features are the large cylindrical condensers which, with their pipes and attachments, occupy the larger part of the room—a fact that will give an idea of the saving in useful space gained by the steam turbine.

The turbine engines of the *Viper* were similar to those of the *Turbinia*, but were in duplicate, consisting of two distinct sets of engines on each side of the vessel. There were four screw shafts in all, acting independently of each other, the two on each side being driven by one high and one low pressure turbine respectively, of about equal power. The two low-pressure turbines drove the two inner shafts, and to each a small reversing turbine was also permanently coupled and revolved idly with them when going ahead.

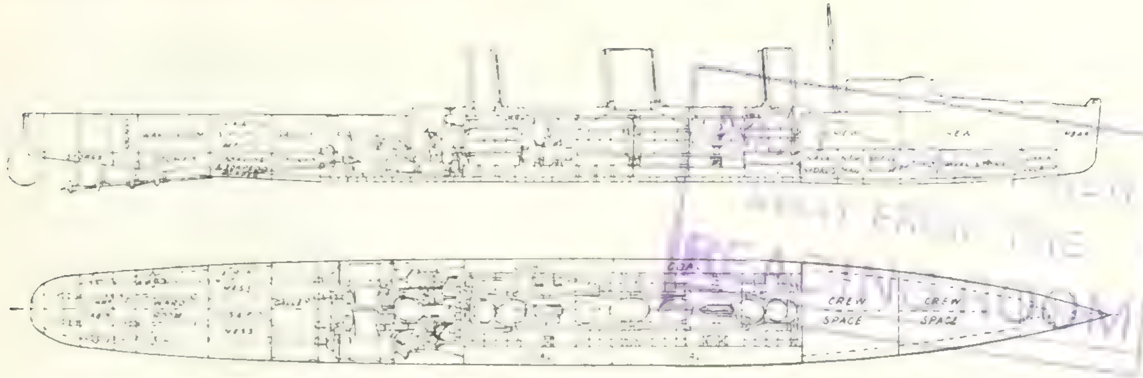
Each shaft carried two propellers; thus the *Viper* was driven through the water by eight screws. The *Turbinia*, it will be remembered, had nine screws and three shafts.

The machinery on each side of the vessel was identical. The steam from the boilers was admitted directly through a regulating valve to the high-pressure turbine, driving one shaft; it then passed to the adjacent low-pressure turbine, driving its shaft independently; thence it flowed to the condenser, and both the shafts then drove the vessel ahead; the reversing turbine revolved with the low-pressure shaft, and being permanently connected with the vacuum of the condenser, no appreciable resistance was offered to its motion under these conditions. To go astern the head steam-valve was closed and the stern steam-valve opened, admitting the steam from the boiler to the reversing turbine and reversing the direction of rotation of the inner screw shaft.

The official trials of the *Viper* took place on May 4th, 1900. The best pair of runs gave 34·67 knots; a 60-ton load was carried, and the



[illegible] SHOWING ARRANGEMENT OF SCREWS ON PROPELLER SHAFTS.



ARRANGEMENT OF MACHINERY IN H.M. TORPEDO-BOAT DESTROYER "VIPER."

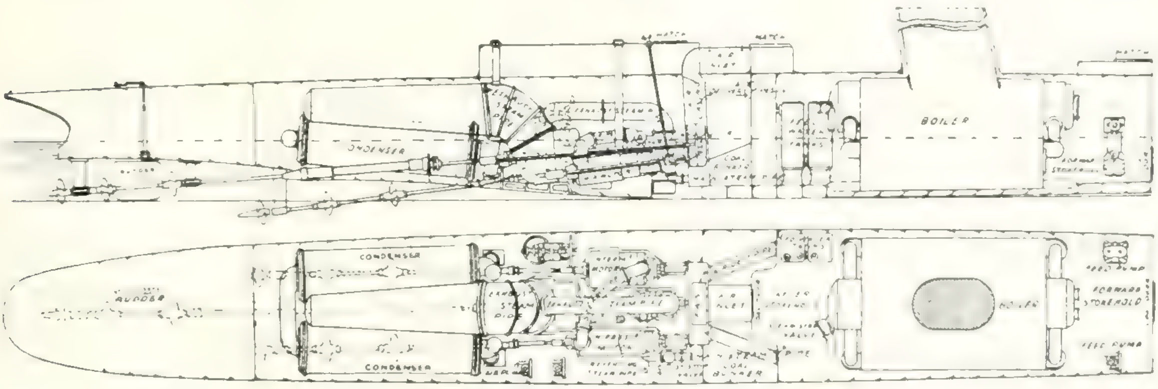
displacement at trial draught was 370 tons. The boat had been in the water some time awaiting her trials, and with a "scrubbed" bottom would have done better; the wind and rough weather were also against high speed.

In July, 1900, the *Viper* underwent one hour's full-power trial off the mouth of the Tyne over the same measured mile, and attained the remarkable speed of 37·113 knots, equal to 43 land miles an hour.

The load carried on the last occasion was above 10 tons in excess of the Admiralty requirements for 30-knot destroyers. The propellers revolved at the high rate of 1,180 per minute; unusually short times were required to work up to full speed, and throughout the trial the machinery worked with the utmost smoothness, and practically no vibration was experienced in any part of the vessel.

H.M.S. "COBRA."

The *Cobra* was laid down in the spring of 1899, and was built by Sir W. G. Armstrong, Whitworth and Co. Like the *Viper* she was fitted with turbine engines by the Parsons Marine Turbine Company. Her length was 223 ft., beam 20·5 ft., displacement 325 tons, and draught 8·2 ft. of water. The preliminary letter naming the conditions of purchase was dated March, 1900. She was supplied with one 12-pounder and five 6-pounder quick-firing guns, and two single training torpedo tubes for 18-in. torpedoes. Her complement was 68 officers and men, and her coal capacity 85 tons. She was fitted with Yarrow water-tube boilers, and her contract speed with an i.h.p. of 11,500 was 35·8 knots. She was launched on June 28th, 1899, and in December, 1899, was offered to the Admiralty. After a lengthened survey by the officers, she was accepted in May, 1900, on the understanding that certain alterations, chiefly strengthening the upper deck to bring her into line with the most recent Admiralty practice, would be made. These were at once carried out, and the vessel was purchased by the Admiralty.



ARRANGEMENT OF MACHINERY FOR "TURBINIA."

Photo by West and Co.]

H.M. TORPEDO-BOAT DESTROYER "TURBINIA" STEAMING 35 KNOTS.

The *Cobra* made her first sea-trial on July 15th, 1899. She had twelve trials, including the Admiralty trials, and in six runs reached a mean speed of 34·8 knots.

Her maximum speed was 35·6 knots. The weather was bad during the trials and there was a heavy swell on.

The *Viper* was lost during the Naval manœuvres in the summer of 1901, owing to her striking a rock in a thick fog.

The *Cobra* went down off the Outer Dowsing Shoal while on her way from the Tyne to Portsmouth, on September 1st, 1901.

H.M.S. "VELOX."

We have already mentioned that this turbine-engined destroyer differs from her predecessors, and the reason is because it was found that the *Viper* and the *Cobra* were not so economical as could be wished when running at ordinary cruising speeds. Excursion steamers and liners usually run at their highest speeds, but war vessels require full power only occasionally, and it was found that the steam turbine, like all steam engines, did not show high efficiency when working much below the power for which it was designed.

The arrangement of the machinery in the *Velox* is as follows: She has two sets of engines, one of the turbine type and the other of the reciprocating type. The main propelling machinery is much the same as that fitted in the *Viper* and *Cobra*. There are two independent sets of Parsons compound turbines, one high-pressure and one low-pressure being on each side of the engine-room. There are thus four turbines, each of which has its own line of shafting; as each shaft carries two propellers, there are eight propellers in all. The high-pressure turbines drive the outer shaft and the low-pressure turbines the inner ones. The turbines are the main engines for high-speed steaming, but for ordinary cruising an auxiliary propelling system is employed. This consists of two small sets of triple-compound marine engines of the ordinary type, which are coupled directly to the main turbines, and work in conjunction with them. They can, however, be disconnected at will. Steam is taken directly from the boilers to the reciprocating engines, and these exhaust through the high-pressure turbines, the exhaust from the latter passing in turn through the low-pressure turbines and thence to the condensers.

When higher powers than those needed for cruising speeds under ordinary conditions are

needed, steam will be admitted to the turbines directly from the boilers. When, however, the highest speed is required, and the maximum power has to be developed which would raise the rate of revolutions beyond that permissible with reciprocating engines, steam will be entirely cut off from the latter, they will be thrown out of gear, and the turbine engines will alone be used.

For going astern, reversing turbines are incorporated in the exhaust casing of each of the low-pressure cylinders.

The *Velox* is 210 ft. long, 21 ft. beam, with a moulded depth of 12 ft. 6 in. Especial attention has been paid by her builders, Messrs. Hawthorn, Leslie and Co., to the strength of the hull, and they claim that she is the strongest destroyer yet built. The boilers are of the modified Yarrow type, and are the same as those fitted in the 30-knot destroyers. They are some 13 per cent. smaller than the boilers of the *Viper*, and have a total heating surface of 13,000 square feet. The builders anticipated that the *Velox* would have about the same speed as the *Viper*. Up to the time of writing, however, her maximum speed has been 33·64 knots, whereas the *Viper* made over 37 knots.

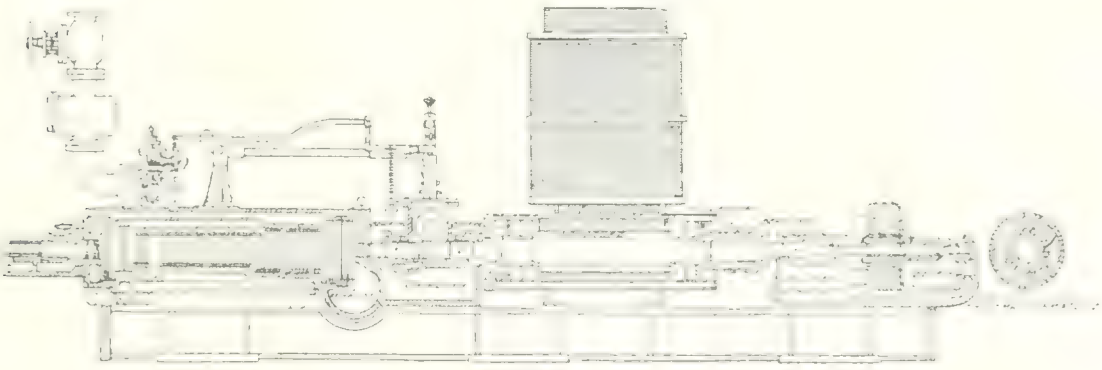
THE FUTURE OF TURBINE WARSHIPS.

Until the *Velox*, the *Eden*, and the *Amethyst* have run their trials, it is impossible to pronounce any definite and final opinion regarding the future of marine steam turbines as applied to men-of-war. Economy is not of the greatest importance here, but rather speed, and it would seem possible that (as Mr. Parsons has said) the benefit will be greater in the case of cruisers and battleships than in the case of smaller vessels. The larger turbines would be cheaper to build, would be lighter in weight, and would occupy less space in proportion to power. The design of large turbines appears to present no difficulties beyond those that have been successfully solved in the case of smaller craft, and the greater size will undoubtedly facilitate the introduction of important refinements for reducing coal consumption.

It may be interesting to quote here Mr. Parsons' description of an imaginary 44-knot cruiser which it is possible may some day actually be constructed :—

> It is, perhaps, interesting to learn the possibilities of speed that might be attained in a special turbine-engined cruiser, a magnified torpedo-boat destroyer of light build, with scanty accommodation for her large crew, but equipped with an armament of light guns and torpedoes. Let us assume that her dimensions are about double those of the 30-knot destroyers, or of the *Viper*, with plates of double the thickness and specially strengthened to correspond with the increased size and speed, length 420 ft., beam 42 ft., maximum draught 14 ft., displacement 2,800 tons, indicated h.p. 80,000. There would be two tiers of water-tube express boilers ; these, the engines and coal bunkers, would occupy the whole of the lower portion of the vessel ; the crew's quarters and armament would be on the upper decks. There would be eight propellers of 9 ft. diameter, revolving at about 400 revolutions per minute, and her speed would be 44 knots. She could carry coal at this speed for about eight hours, and she would be able to steam at from 10 to 14 knots with a small section of the boilers and supplemental machinery more economically than other vessels of similar size and of ordinary type and power, and when required all the boilers could be used and full power exerted in about half an hour.

It may be remarked that in the history of engineering progress, the laws of natural selection generally operate in favour of those methods which are characterised by



the greater simplicity and greater economy, whether these advantages be great or small.

THE STEAM TURBINE APPLIED TO PASSENGER VESSELS.

Two turbine-engined excursion steamers, the *King Edward* and the *Queen Alexandra*, have been regularly running on the Clyde this summer. The Earl of Glasgow, in a recent presidential address to the Institution of Naval Architects in Glasgow, predicted that the *King Edward* would create a revolution in the coast passenger carrying trade in the Clyde. The following particulars of this vessel, the first turbine-engined passenger steamer in the world, may be of interest:—

The *King Edward* is 250 ft. long and 30 ft. wide. Her moulded depth is 10 ft. 6 in. to the main deck, and 17 ft. 9 in. to the promenade deck. In general arrangement for passenger accommodation she is similar to the *Duchess of Hamilton*, a favourite Clyde paddle-wheel steamer. Her builders are Messrs. William Denny and Brothers, of Dumbarton, and she has been constructed to the order of Captain John Williamson, of Glasgow, who represents the syndicate which own her. The propelling machinery consists of three Parsons steam turbines working compound. These are placed side by side. In ordinary working, and when going ahead, steam is admitted from the boilers to the high-pressure turbine, where it is expanded fivefold. From thence it passes to the two low-pressure or wing turbines placed one on each side, where it is expanded 25-fold, and then passes to the condensers. The total ratio of expansion is therefore no less than 125-fold. Each turbine has its own shafting; and on each side of the wing shafts there are two propellers, while the centre one carries only a single screw. When coming alongside a pier, or manœuvring in crowded waters, the wing motors alone are used, steam being admitted directly into them by suitable valves. The high-pressure turbine is then shut off, the steam admission valve being closed, whilst connection between it and the low-pressure turbines is also shut off by an automatic arrangement. There are special turbines placed inside the exhaust ends of the low-pressure turbines for going astern with the wing screws. The whole of the manœuvring, excepting, of course, by the rudder, is effected by the manipulation of valves in a very simple manner. The feed-pumping engines are worked separately, as are the circulating pumps and fans for forced draught. The main air pumps are worked by means of worm-gearing from the wing shafts; but there are auxiliary air pumps, actuated by the circulating pump engines, for clearing the condensers of water when the main engines are not in operation. There is a feed-heater which uses the exhaust steam, or steam taken from an intermediate point in the turbines if necessary. There is also a filter to clear the steam of grease. Other machinery common to vessels of this class is fitted. The boiler is of the usual return-tube type, being double-ended, and having four furnaces at each end. It is placed in a closed stokehold.

Photo by R. Parry

H.M. "VELOX" MAKING 33·64 KNOTS IN THE NORTH SEA, SEPTEMBER, 1902.

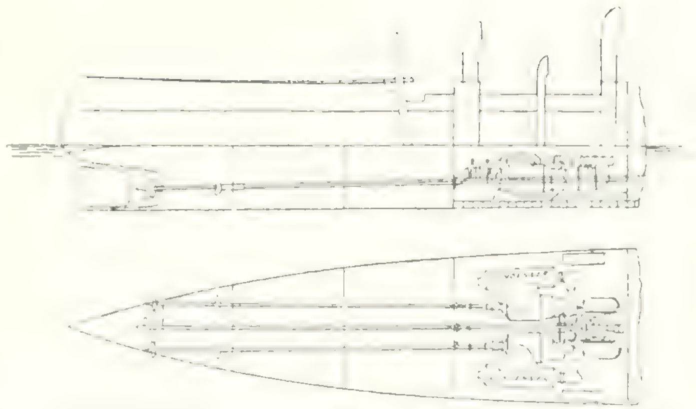
On her first trial the *King Edward* made 20·48 knots, thus creating a record on the Clyde, and exceeding in speed most of the competitors

Marine Steam Turbines.

by one or two knots. The mean revolutions were 740 per minute, the steam pressure in the boilers was 150 lbs. to the square inch, and the vacuum $28\frac{1}{2}$ in.

The air-pressure in the stokehold was equal to 1 in. of water. The indicated horse-power was estimated at 3,500, but there is no available method of taking indicator diagrams with this type of motor.

The *Queen Alexandra* on her trials, in the summer of this year, made 21·63 knots, thus beating the *King Edward*, and, by a knot and a quarter, proving herself to be the fastest excursion steamer in the world.



ARRANGEMENT OF MACHINERY FOR PROPOSED 25-KNOT [illegible] OF 10,000 H.P.

She [illegible] the *King Edward* [illegible] larger dimensions, [illegible] length being 270 ft., breadth moulded 32 ft. and depth to promenade deck 18 ft. [illegible]. Like the *King Edward*, [illegible] strongly resembles a small cross-channel steamer in appearance. The main engines consist of three separate turbines, each driving its own shaft, the centre turbine being high-pressure and the two side turbines low-pressure. The total ratio of steam expansion is about 125-fold as compared with 8 to 16-fold in triple expansion reciprocating engines, and at ordinary steaming rate the velocity of the centre shaft is 7,000, and that of the side shafts 1,000 revolutions per minute. A long deck house, on which boats are carried and passengers are allowed to promenade, is a new feature in this vessel. The promenade deck itself extends almost the whole length of the vessel, and is fitted with buoyant seats.

The steam steering gear is by Messrs. Bow, M'Lachlan and Company, of Paisley, controlled by a wheel on the flying bridge. She is driven through the water by five propellers, and is reversed by astern turbines placed inside the exhaust ends of the low-pressure turbine cylinder, which reverse the action of the two shafts. A powerful windlass, with warping capstan attached, is fitted forward for working the main cables, and a steam warping capstan, both by Messrs. T. Reid and Son, of Paisley, is fitted aft for warping vessels alongside of piers. The vessel is lighted throughout by electricity, the installation being carried through by the builders; the wiring is done on the concentric system. The boiler, which is a large double-ended one, having a funnel at each end, is supplied by Messrs. Denny and Company; and the turbines, of which there are three, by the Parsons Marine Steam Turbine Company, of Wallsend-on-Tyne.

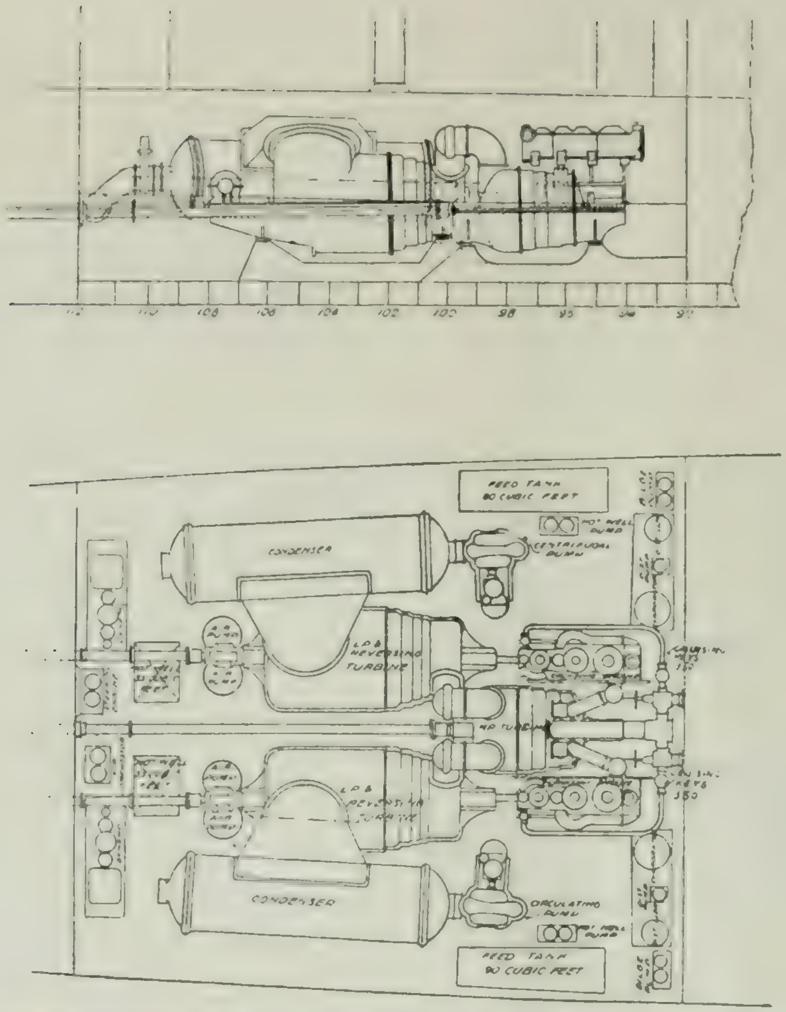
SPEED AND COAL CONSUMPTION OF TURBINE VESSELS.

At the launch of the *Queen Alexandra* Mr. James Denny made some interesting remarks respecting the speed and coal consumption of turbine vessels, which may be quoted here :—

Many irresponsible statements had appeared in the Press regarding the *King Edward*, and he thought it would not be out of place were he to give a few figures which were the result of actual experiments and trials with the vessel. If the *King Edward* had been fitted with balanced twin triple-expansion engines of the most improved type, and of such size as would consume all the steam the existing boiler could make, her displacement would have been slightly increased to carry the extra weight of triple engines as compared with turbines. Under these conditions, the best speed they could possibly have got would have been 19·7 knots, against 20·5 knots actually done by the *King Edward*. Thus the increase of speed was eight-tenths of a knot per hour. Two-tenths of this was due to the lesser displacement in the *King Edward* as a turbine steamer, and six-tenths was due to the superior efficiency of the turbine engine and its accessories. The difference between 19·7 and 20·5 knots corresponds to a gain in i.h.p. in favour of the turbine steamer of 20 per cent.; but it would hardly have been possible to drive the *King Edward* 20·5 knots with ordinary engines at all, owing to the extra weight and the necessarily increased displacement. The attempt to do so could only have resulted in this speed being got at an enormously increased first cost and increased expenditure of coal and [illegible].

Referring to the question of coal consumption, he said :—

The *Duchess of Hamilton* and *King Edward* [illegible] on service had been compared. From the comparison it had been found that the *Duchess of Hamilton* at 16·5 knots burned 16 tons, and the *King Edward* at 18·5 knots burned 18 tons. The *Duchess of Hamilton*, however, had only compound engines; by the use of triple engines her consumption could be reduced; but even with triple engines, if she were to be driven at 18·5 knots on service, her consumption would have been over 22 tons, as against 18 tons in the *King Edward*, which corresponded to a saving of about 20 per cent. in favour of the latter. This was on the assumption that the *Duchess of Hamilton* was left as she was in displacement and draught, and that she could have carried machinery powerful enough to



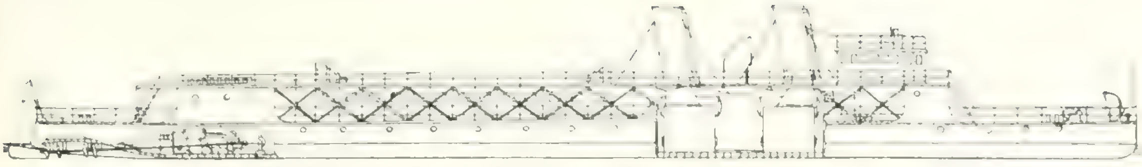
VIEW OF TURBINE MACHINERY FOR PROPOSED 23-KNOT CRUISER OF 10,000 H.P.

of some 18·5 knots on service, but as her speed on trial was only 18 knots, the greater displacement necessary to carry the increased weight of machinery for the higher speed would have resulted in a considerable increase on the coal consumption of 22 tons. There was another question in regard to the coal consumption of turbines. It was well known that turbine engines at a much lower power than that for which they are designed are not so economical as ordinary engines. Up to the highest speed at which the *King Edward* had been driven they had found an always increasingly favourable consumption of coal in relation to the speed of the vessel, but they had no means of knowing how far this tendency might reach. However, they had ascertained that her speed would have had to be reduced to between 17 and 18 knots, as on trial, before ordinary engines, under the same conditions and at the same speed, would burn less per knot of speed; that 17 or 18 knots speed corresponded to about 60 per cent. of the total maximum power of the turbine engine in the *King Edward.* The up-keep of the turbine engines for the season had been very slight. As to cost, even including the royalties charged, they found that turbines were not more expensive than other engines, and they thought, with more experience in their manufacture, they would ultimately become considerably cheaper. If the *Queen Alexandra* turned out to be as successful as the *King Edward* was, it was almost certain there would be a very large application of turbine machinery.

ECONOMY OF TURBINES AT LOW POWERS.

The Hon. C. A. Parsons said he would like to supplement the statements of Mr. James Denny by a few remarks as to economy of turbines at low powers :—

In Clyde passenger steamers, indeed in practically all passenger steamers, which always ran at or near full



DESIGN OF 20-KNOT SHALLOW DRAUGHT BOAT, FITTED WITH TURBINE MACHINERY.

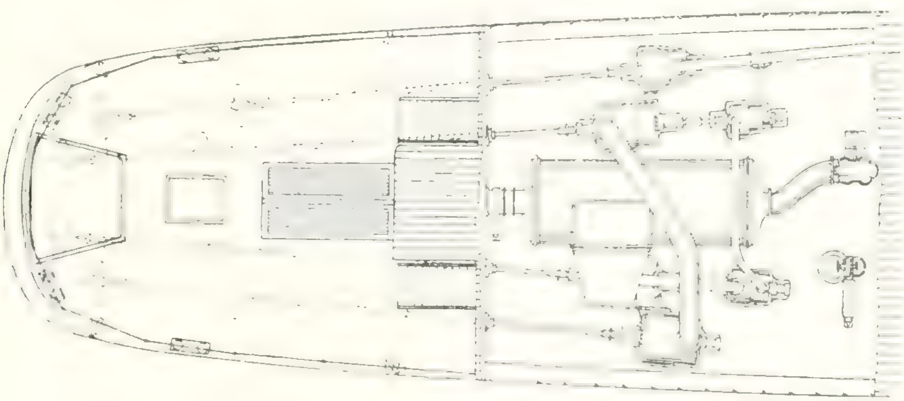
power, there was no need to study the question of economy at low powers, but when they came to war vessels, most of whose service was performed at cruising speed, when the power exerted was perhaps only one-tenth of that at full speed, then this question of economy at low powers became of great importance. Arrangements had been made to solve this difficult problem in several different ways. For instance, the number of turbines might be increased, and there was no doubt in his mind that they could by this and other means make turbines certainly as economical—probably much more economical than ordinary engines at the same low power—while at high speeds the turbines would have an advantage of from 20 to 30 per cent.

FORTHCOMING DEVELOPMENTS.

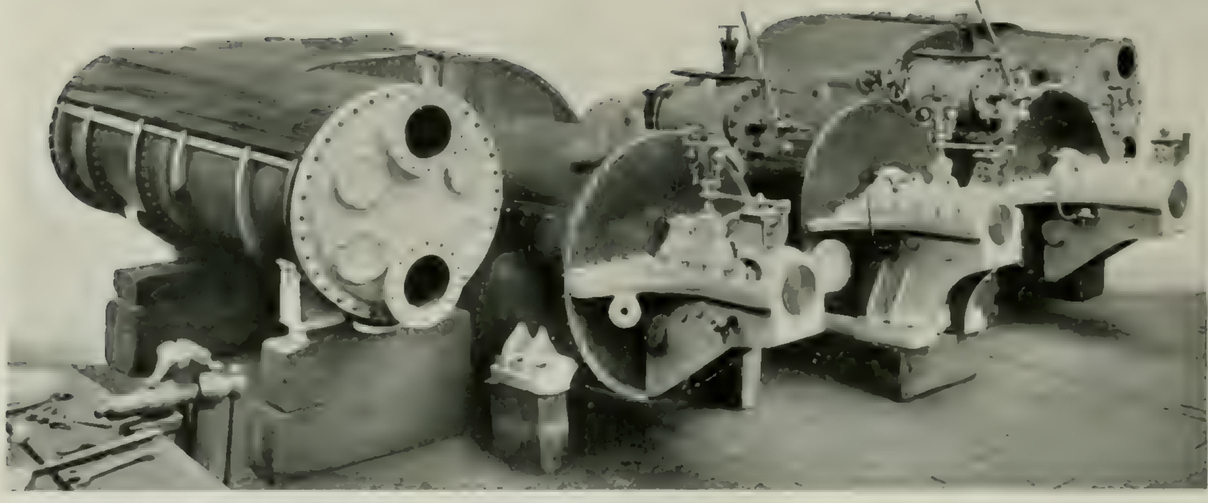
It has been announced within the last few weeks that the South-Eastern and Chatham Railway Co. have ordered a new turbine steamer, which is to be built by Messrs. Denny, and to be delivered for next season's traffic, and which for speed, comfort, and convenience is expected to create a revolution in cross-Channel passages. The length of the vessel will be 300 ft., and she will have a beam of 40 ft. She will be entirely different from the present type of mail packet. The upper or promenade deck is to have an over-head shelter, so that passengers can obtain protection in rough weather without going below. Extensive cabin accommodation will also be provided. The turbine machinery will occupy such a small space that much additional room will be obtained for the use of passengers. The builders calculate that the cross-channel passage between Dover and Calais will be covered by the new steamer in 45 minutes at the outside, and probably, under favourable circumstances, in less. The average passage now is 65 minutes, and the record passage is 59 minutes. The speed of the new steamer will be 25 knots an hour, as compared with the 18 to 20 knots made by the present boats on the present service. It has been stated that the Parsons Marine Steam Turbine Company have offered to fit up, free of cost, turbine engines on a Cunard liner, and that Mr. Wilson, President of the Atlantic Shipping Company, is negotiating for the construction of some 30-knot turbine steamships, which will make the voyage from New York to Bremerhaven in four days. Messrs. Denny are building also a turbine steamer for the London, Brighton, and South Coast Railway for their Newhaven-Dieppe service.

FUTURE OF THE MARINE STEAM TURBINE.

It may be interesting to quote here a statement made by the Hon. C. A. Parsons in a recent lecture at the Royal Institution, London, on the future of the marine steam turbine :—



[illegible] TURBINE MACHINERY [illegible] 20-KNOT [illegible] DRAUGHT BOAT.



SET OF TURBINE MACHINES, AS FITTED IN THREE HIGH-SPEED YACHTS AND PASSENGER STEAMERS.

In regard to the general application of turbine machinery to large ships, the conditions appear to be more favourable in the case of the faster class of vessels, such as cross-Channel boats, fast passenger vessels, liners, cruisers and battleships; in all such vessels the reduction in weight of machinery and economy in the consumption of coal per horse-power are important factors; in some, the absence of vibration is a question of first importance as affecting the comfort of passengers, and, in the case of ships of war, permitting of greater accuracy in sighting the guns.

I have had constructed a model representing a proposed cross-Channel boat for the Dover and Calais or Newhaven and Dieppe routes. She is 270 ft. length, 33 ft. beam, 1,000 tons displacement, and 8 ft. 6 in. draught of water. She has spacious accommodation for 600 passengers, and with machinery developing 18,000 horse-power would have a sea speed of about 30 knots, as compared with the speed of 19 to 22 knots of the present vessels of similar size and accommodation.

Again, in a lecture delivered before the Institution of Engineers and Shipbuilders in Scotland, Mr. Parsons said that the marine steam turbine would be found to be superior, or at least equal in economy of coal to the reciprocating engine when placed in fast vessels of the mercantile marine. In the case of an Atlantic liner, turbine engines would effect a reduction in weight of machinery, and also increased economy in fuel, tending either to a saving in coal on the one hand, or, if preferred, to some increase in speed on the same coal consumption per voyage.

ITS PRINCIPAL ADVANTAGES.

The principal advantages of the turbine system of propulsion for passenger steamers of all classes, compared with vessels fitted with ordinary engines, are as follow:—

(1) Increased speed for the same boiler power due to considerably reduced weight of machinery and increased economy in steam. (The advantage increasing with higher powers and speeds.)

(1a) Same speed, with reduced boiler power and reduced coal consumption for the same reason as (1).

(2) Absence of vibration, giving greater comfort to passengers.

(3) Increased cabin accommodation, due to smaller machinery space.

(4) Less up-keep in machinery, and smaller engine-room staff.

HIGH-SPEED TURBINE YACHTS.

The possibilities of the steam turbine for yacht propulsion have recently been attracting the attention of the yachting world. Two yachts, which are to be fitted with the Parsons marine steam turbine, have recently been launched, whilst a third is in the stocks. Their names are *Tarantula*, *Emerald*, and *Lorena*.

The first to be launched was the *Tarantula*, built by Messrs. Yarrow and Co., of Poplar, for Col. McCalmont, M.P., from the design of

Messrs. Cox and King, of London. She is a unique vessel, in that she has been built on the lines customary with vessels of the torpedo-boat class. As regards her hull and boilers she is practically identical with a modern first-class torpedo-boat, the only difference being in the propelling machinery. Her boilers are of the Yarrow water-tube type, and we believe that she is the first yacht to be fitted with water-tube boilers. The *Tarantula* is 160 ft. long, with a 16 ft. beam; the machinery consists of three turbines, one high pressure and two low pressure. Each drives three shafts, and there are three propellers on each shaft. She is therefore driven through the water by nine screws. The question of propellers is one that has long exercised the attention of Mr. Parsons, and his experimenting may be expected to lead to important results. The trials of the *Tarantula* have been carried out with some secrecy. Her designed speed was 24 knots, and she is believed to have made 26·745 knots when loaded to a displacement of 150 tons. Doubtless a full series of trials will be made, and comparison will then be possible between the turbine-driven *Tarantula* and a first-class torpedo-boat whose engines are of the reciprocating triple-expansion type, and whose horse-power is about 2,000.

THE "EMERALD."

The *Emerald* was launched the other day. She was constructed to the order of Sir Christopher Furness, M.P., D.L., from the designs and under the direction of Mr. Fred. J. Stephen, the managing director of the Linthouse Shipyard, Glasgow, by Messrs. Alex. Stephen and Son, Ltd. She is 236 ft. long, 28 ft. 8 in. beam, and 18 ft. 6 in. moulded depth, giving a tonnage of 956 tons yacht measurement. She has been constructed under Lloyds' special survey to class 100 A1. Her propelling machinery consists of three sets of Parsons steam turbines, each of which drives one propeller shaft, one propeller of about 3 ft. diameter being attached to the centre, and two propellers, each of about 20 in. diameter, to each of the side shafts.

At the launch of the *Emerald*, Sir Christopher Furness remarked that what Mr. Parsons, Mr. Stephen, and he himself had in view in fitting the *Emerald* with turbines, was to put into the vessel such power as would enable her to steam at the highest rate compatible with entire freedom from vibration. He believed that object would be attained, and still further he believed, as a business man and as one engaged with ships and shipping, that the steam turbine would practically revolutionise yachting and yacht owning in this country.

Mr. G. L. Watson, the well-known yacht designer and yacht builder, on the same occasion, said that if the marine steam turbine was proved to be economical at low speeds it certainly had a great future.

The *Tarantula* has been designed as a yacht of exceptionally high speed (24 knots), but the *Emerald* is to steam 16 knots at her maximum. Seeing that yachts seldom cruise for long periods at so great a speed as 16 knots, but for the most part indulge in gentle cruises at lower speeds, it seems doubtful whether yacht owners will take very keenly to the steam turbine. Whether the *Emerald* will prove as economical as regards coal consumption at various speeds as a similar yacht with reciprocating engines remains to be seen.

As regards vibration, it is doubtless possible so to strengthen the hull as to prevent any discomfort from the rapid revolution of the propeller shafts.

THE "LORENA."

Another turbine yacht under construction at the present time is the *Lorena*. The hull and boilers are being supplied by Messrs. Ramage and Ferguson, of Leith, Scotland, and the machinery by the Parsons Company. She is being built to the order of Mr. A. L. Barber, of New York. She will displace about 1,400 tons, and she will be 252ft. 3in. long by 32ft. 6in. beam, and moulded depth 21ft. Her indicated horse-power is to be 2,500, and her speed about 16 knots. She has been designed by Messrs. Cox and King, of London. The turbine machinery will be very similar to that fitted in the *Emerald*.

MILLING MACHINES.

BY

JOSEPH HORNER.

Treats of Profiling Machines, in which outlines of irregular shape are produced by the aid of a pattern or former similar in outline.

VI.

IN profiling machines, which are now very numerous, there is a large range of sizes; and besides this, numbers of ordinary vertical spindle machines have provision for converting them into profilers when required.

It is because irregular outlines are so very costly to shape by any other method in other machines, or by hand, and are practically incapable of interchangeable production by such methods, that the milling machine is of the highest value, and scores most heavily in this class of work.

GENERAL CONSTRUCTION.

The principle is illustrated in fig. 1, in which A is the former, B a pile of work, the shape of each piece in which is controlled by the movement of the tracer, C, around the edge of A. The spindle head or slide, D, is free to follow the irregular movements of C. The exact longitudinal adjustments of C are provided for in large machines by a sliding block, E, in which the stem of C has its bearings, and these are controlled by a screw. The taper form is imparted to the tracer pin, C, in order to provide for coarse and fine depths of cut, effected by raising or lowering the tracer.

It is easy to understand that in movements of this kind any lost motion in the fitting, either of the spindle and its head, or of the tables, would be fatal to accuracy of results. Provision is therefore made for taking up wear as soon as it begins to develop.

In all the lighter types of profilers there are two movements to the cutter, one horizontally by the sliding of the head bodily, and one vertically by the sliding of the cutter spindle alone. The first is controlled by the former and tracer pin, the second by hand. In most machines the head and pin are maintained in contact with the former by the pull of a suspended weight. In some of the smallest machines, however, a handle alone is used for imparting the pull. The sliding head in good machines is carried on rollers on the top edge of the horizontal, or cross rail, to lessen friction. In order to allow for the ever-changing horizontal positions of the sliding head, the spindle pulley is driven by a half-crossed belt from a long drum at the rear. The work is carried on a sliding table, which is operated by hand or by power.

A TYPICAL MACHINE.

The mechanism of a profile milling machine is best studied in the front and side elevations, given in figs. 2 and 3, of one of the latest forms built by Messrs. Webster and Bennett, of the Atlas Works, Coventry.

The spindle, A, is driven from the long drum, B, on the same shaft as the three-stepped cones,

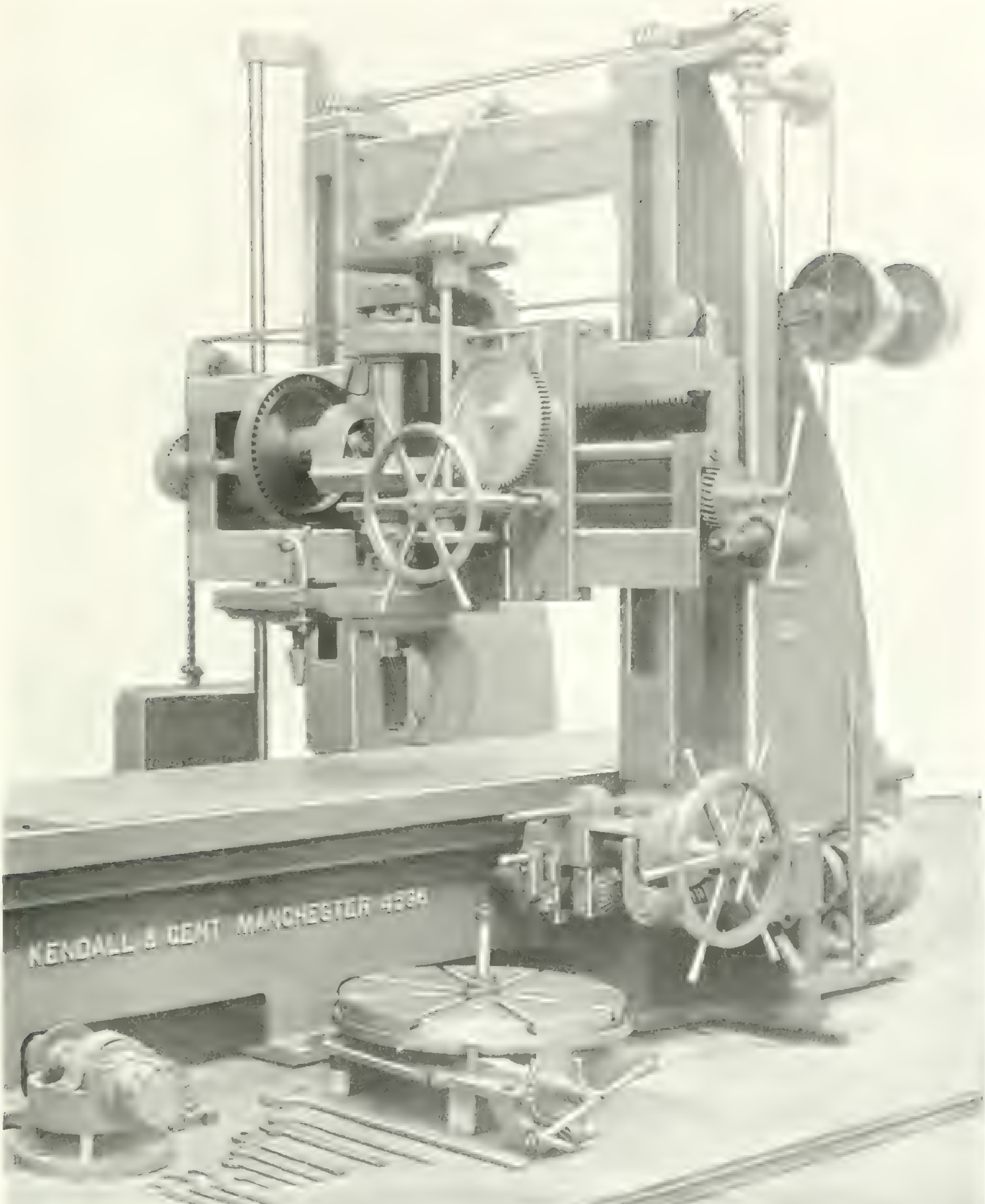


FIG. 19.—HEAVY SLOTTING MACHINE.
KENDALL AND GENT, MANCHESTER.

with a quarter-twist belt. The slide, C, in which the spindle has its bearings, has a range of vertical travel on the carriage, D ($3\frac{1}{2}$ in. in this case), and is counterbalanced by the weight, E, at the end of the quadrant rack. The carriage, D, runs on its cross rail, on rollers, in order to render its working as easy as possible ; *a* is the former pin, which being held against the former or pattern by the weight, F, and so pulling the slide, D, imparts its pattern to the work upon the table. By clamping the saddle on the cross slide the machine can be used as a vertical miller for plain work within its range, including such operations as slot drilling, face milling, etc.

The table feeds include one longitudinal, accomplished in this case with rack and pinion, and a circular drive with worm gear. The longitudinal feed is derived from the stepped cone, F, through spurs, bevels, worm and worm wheel, and again through spurs to the rack, the course of which is clearly indicated in the two views. Stops, *bb*, strike a lever, *c*, and reverse the motion through the claw clutches on the worm shaft. The table can be moved and adjusted by hand from G. The gear for the feed of the circular table is seen at the right of fig. 2. It comprises worm and spur gears, which can be thrown out instantly by the clutch, by hand. The table has the sud trough round it, without which no machine is now considered complete. All the gears are machine cut, and protected by guards. Provision is made for taking up wear, so that no lost motion shall occur in the movements of the table. A pump is seen at H, belted from the main driving shaft. The body of the machine forms a tank for suds. A tool cupboard is also fitted. The spindle is of steel, hardened and ground, and runs in adjustable bearings of gun-metal.

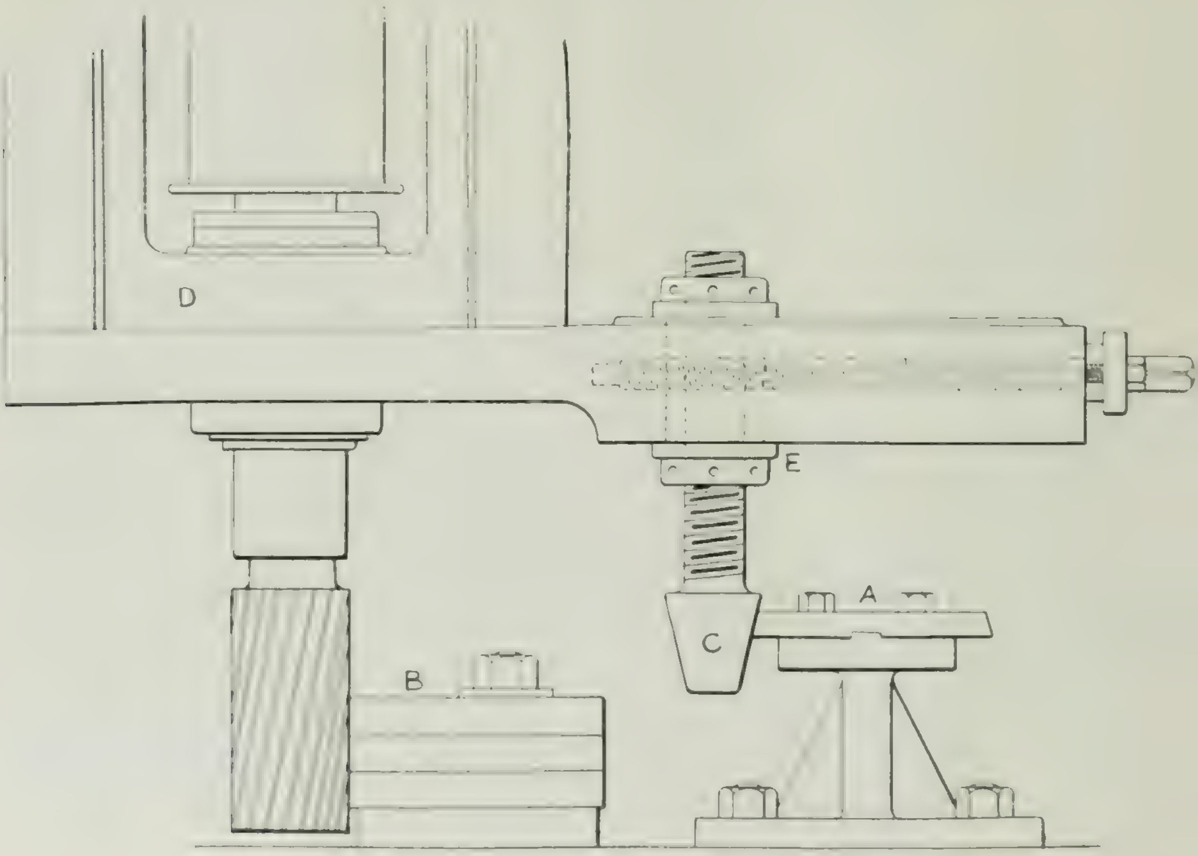


FIG I.

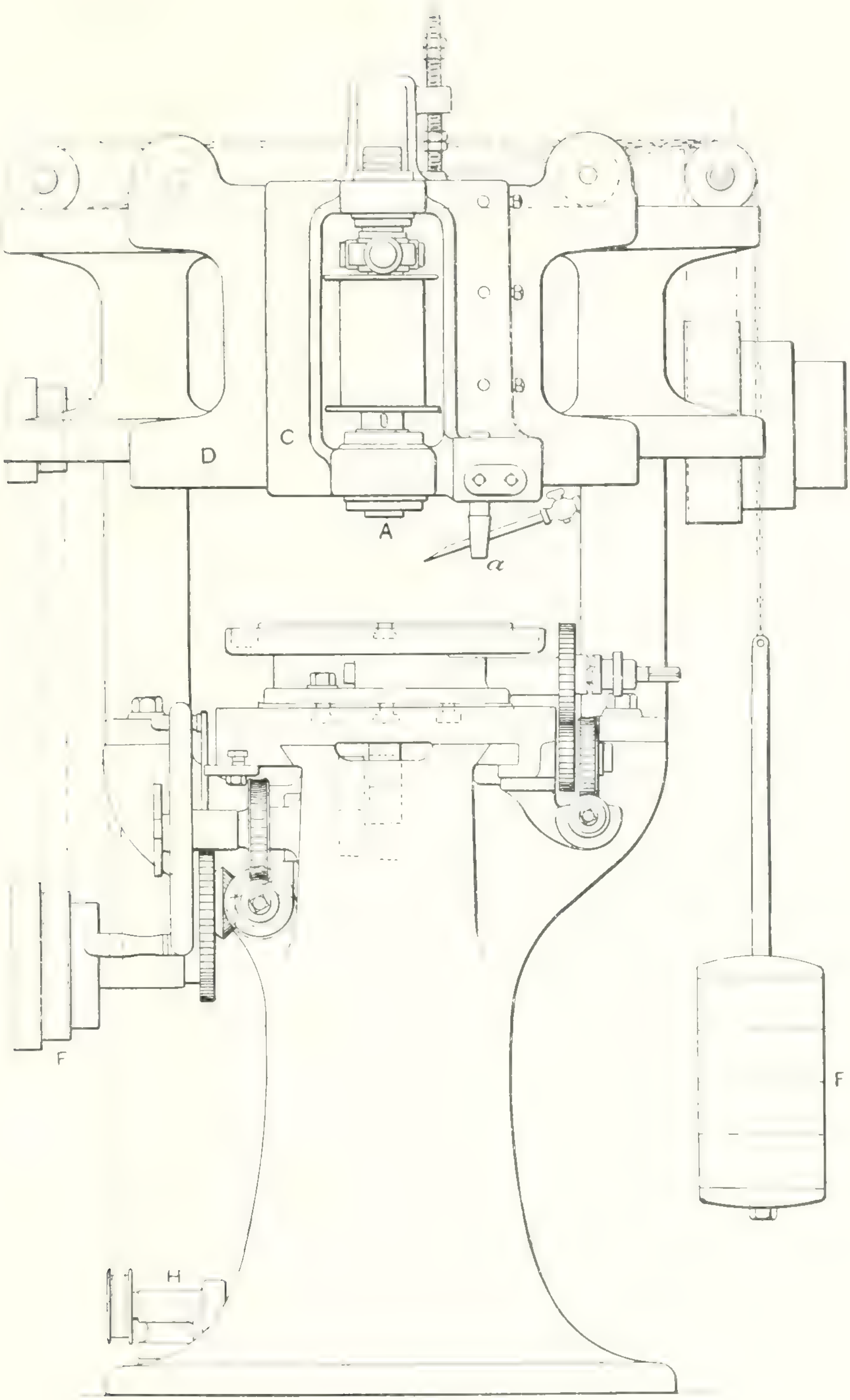


FIG. 2.

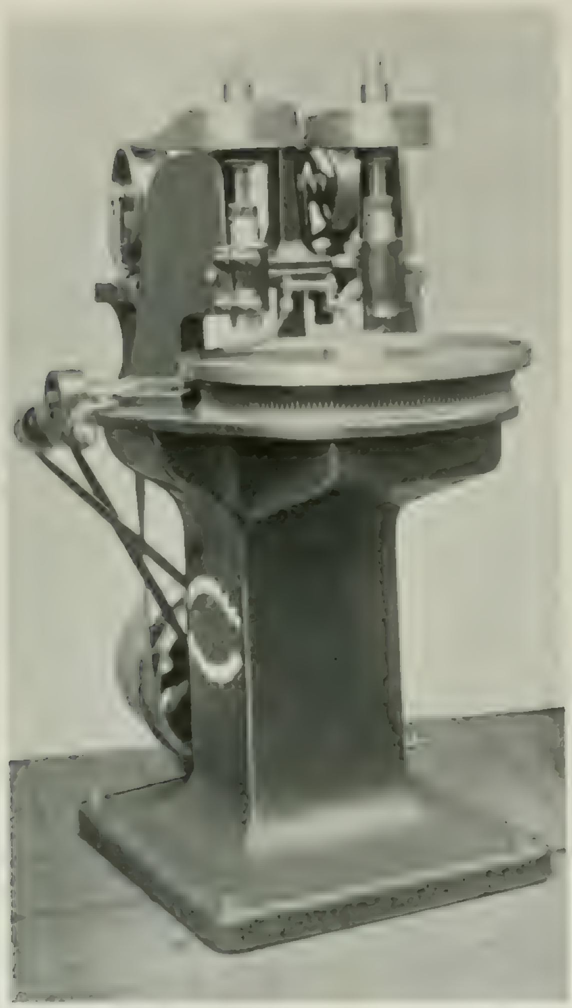


FIG. 4. DOUBLE-SPINDLE VERTICAL MILLING MACHINE.
H. W. WARD AND CO., BIRMINGHAM.

The end thrust is taken on ball collars. This machine weighs about a ton.

TWO-SPINDLE MACHINES.

A good many machines are made with two spindles, examples being given in figs. 8 and 17. These machines fulfil two useful functions, since each spindle can be used on a separate piece of work dissimilar, or else identical, in form. In the first case the output is doubled; in the second, one spindle will take a roughing and the other a finishing cut.

THE WARD MACHINE, WITH TWO SPINDLES.

Figure 4 illustrates a very handy two-spindle machine by Messrs. H. W. Ward and Co., of Birmingham, which, though not a true profiler, may be considered as a connecting link between the plain vertical spindle machines, and the profilers. It is designed for doing circular work, the edges of which can be milled to any sectional form. The table is rotated by worm and wheel, and the spindles are driven by a single belt passing around idlers to flanged pulleys at the spindle heads. The advantage of being able to take a roughing and a finishing cut on work without resetting is very great. The value of this when large numbers of similar pieces have to be turned out to interchange is obvious. A pump supplies lubrication, which is drained off into the body of the machine, to be pumped up again.

THE ARCHDALE MACHINES.

Messrs. James Archdale and Co., of Birmingham, make a speciality of profiling machines, of which the firm manufactures several sizes and types, forming an important section of the plant for arsenals. Fig. 5 illustrates one of the smaller sizes, having an 8-in. horizontal traverse of the spindle, and a table measuring 15 in. by 12 in. The horizontal drum from which the spindle is driven is partly seen behind, and also the counter-balance of the spindle. The horizontal slide runs on rollers, and the same lever at the front, which moves the vertical slide, also pulls the horizontal slide and pin against the former or pattern. The table feed is by a hand wheel, through spur gears to a rack, and the wheel which gears with the rack is in halves, so that back lash can be taken up. The machine framing contains a reservoir for suds, which are pumped thence up to the cutter.

A heavier machine by this firm is shown in fig. 6, in which, instead of being merely hand-operated, all motions are self-acting. The cross slide is pulled over to its work by a weight, and it has self-acting transverse traverse by worm gears and a screw. The vertical slide is counterbalanced by springs, and adjusted by hand wheel and screw. The table is fed and reversed automatically in the longitudinal direction, and the removable circular table is also self-acting. The base is utilised as a tank.

A very fine profiling machine by the same makers is shown in fig. 7, being back-geared, and having a table measuring 4 ft. 6 in. by

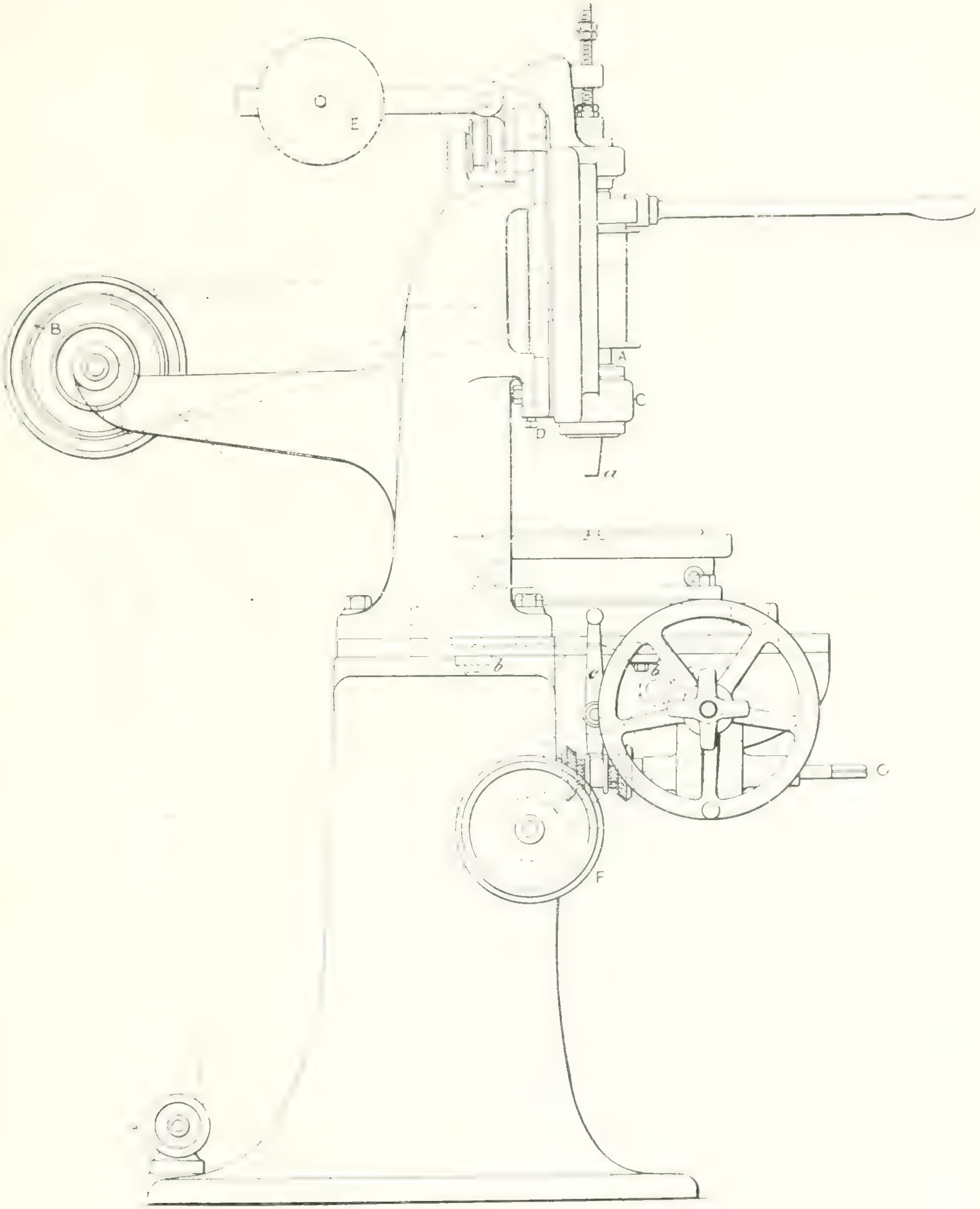


FIG. 3.

2 ft. 4 in. The machine can be used as a profiler, or for ordinary work. For the former it is furnished with a chain and weights, for the latter the cross slide is rendered self-acting by gears. The vertical slide is counterbalanced by a weight dependent from chains. The table has quick return motion in each direction. All feeds are self-acting, and all have hand adjustments also. The feeds are driven through friction. There are sixteen changes of speed to the cutter spindle.

A DOUBLE-SPINDLE REINECKER MACHINE.

A large profiling machine (fig. 8), by J. E. Reinecker, of Chemnitz-Gablenz, represented by Messrs. Pfeil and Co., of Clerkenwell, differs in several respects from other designs. Thus, it has separate spindles for slow and quick speeds, the latter being driven from the former. But the wear on the large slow-speed spindle is much less than it would be if run at a high rate of revolution. When the main spindle is in use, the secondary one is thrown out of gear. In the machine shown the spindle rates are as three to one. The driving is done through stepped cones and back gears, having a ratio of 16⅓ to 1, and bevel wheels to the spindle. Another feature is that instead of the profiling action being effected by drawing over the spindle head against a former, the table slide is

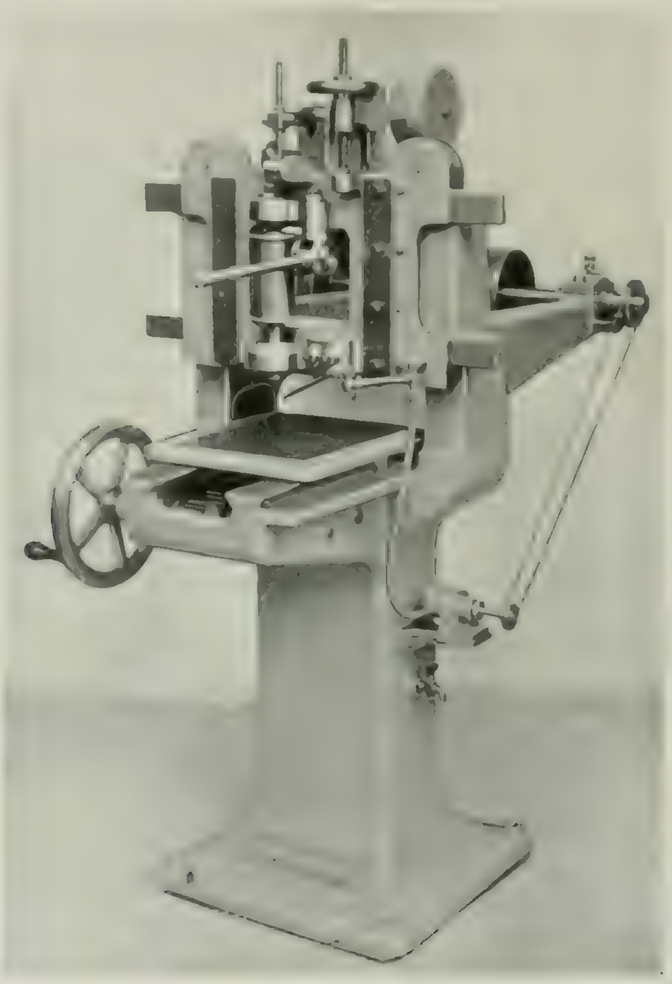


FIG. 5. ONE OF THE SMALLER PROFILING MACHINES.
J. ARCHDALE AND CO., BIRMINGHAM.

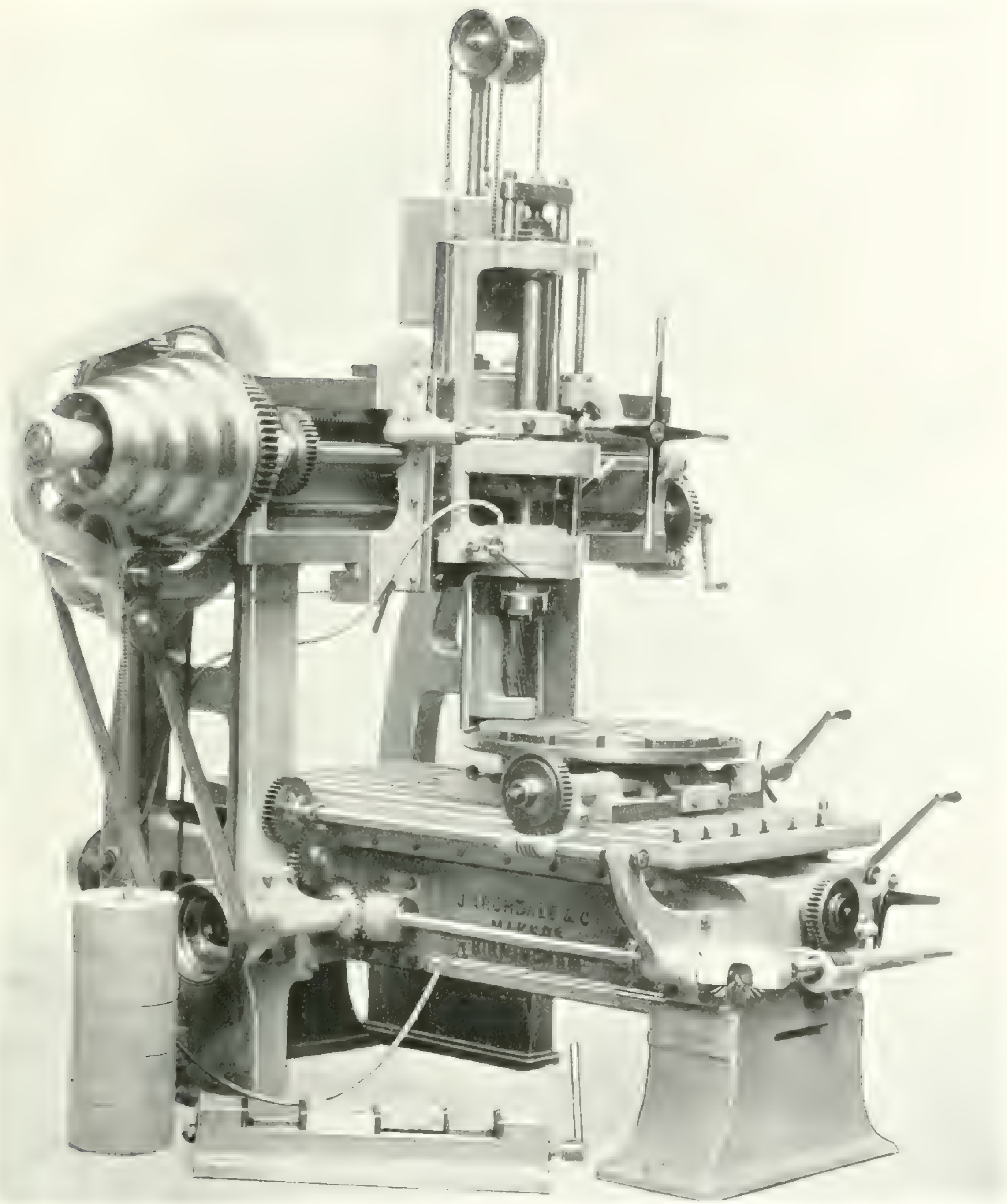


FIG. 7. VERTICAL MILLING MACHINE, WITH PROFILING [illegible]
J. ARCHDALE AND CO., [illegible]

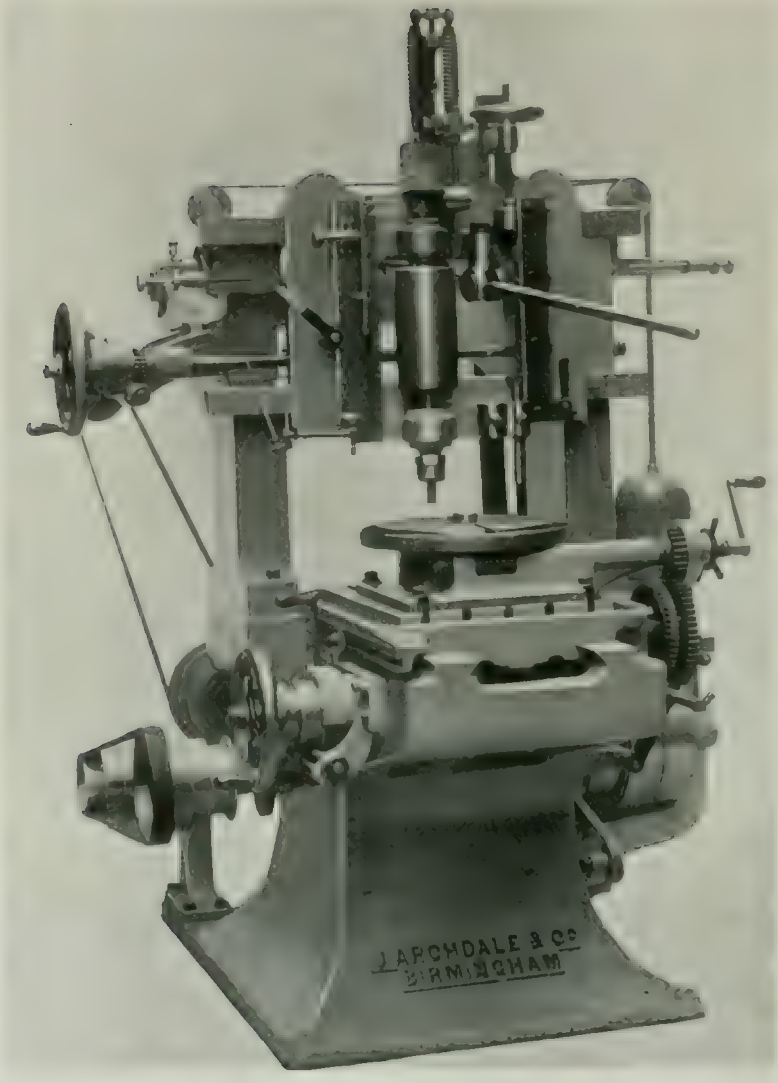


FIG. 6. SELF-ACTING PROFILING MACHINE.
J. ARCHDALE AND CO., BIRMINGHAM.

moved. The profiling roller is carried in a bracket which is bolted to, and adjustable on the base of the main frame. Circular milling is provided for by a round table, not shown. Feeds are automatic, the transverse feed varies from $\frac{5}{16}$ in. to 7 in. per minute. The table has a quick return motion, nineteen times faster than the feed. The size of the machine is a striking feature. It weighs nearly $8\frac{1}{2}$ tons, and the working surface of the table measures 6 ft. $2\frac{3}{4}$ in. by 1 ft. $11\frac{3}{4}$ in. The bottom spindle bearing is $6\frac{5}{16}$ in. in diameter, by $11\frac{3}{8}$ in. long, the upper one $4\frac{1}{4}$ in. by 8[illegible] in.

SPECIALISED MACHINES BY WEBSTER AND BENNETT.

Messrs. Webster and Bennett, of Coventry, make some patented profile milling machines of unusual and interesting types, both horizontal and vertical. Two horizontal machines are shown in figs. 9 and 10, the first for work of a general character, the second for special purposes.

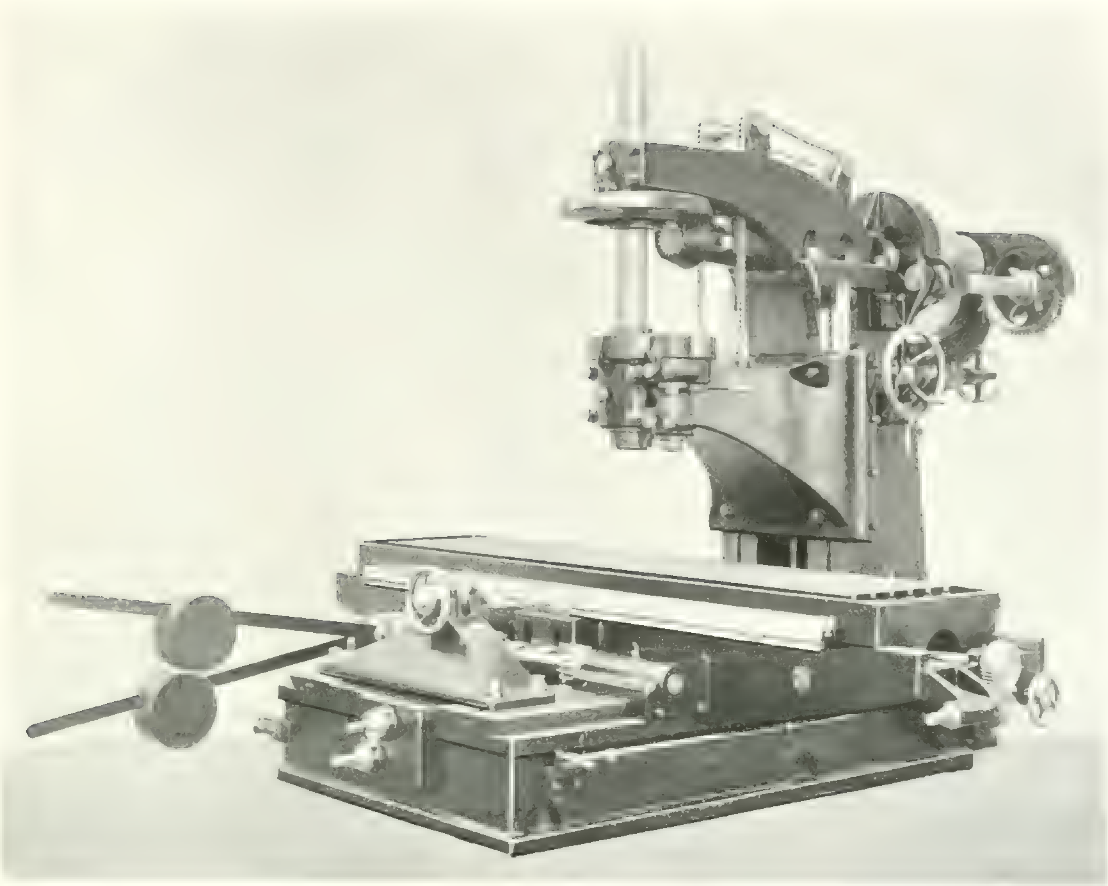


FIG. 8. HEAVY PROFILING MACHINE.
J. E. REINECKER, CHEMNITZ-GABLENZ.

The machine in fig. 9 is double-headed—that is, there are two cutter heads, and two work heads carried on one bed, so that one attendant can mind two pieces of work. The weights seen below hold up the roller or tracer against the cam or former plate, and so move each work head to and fro. The hand levers seen in front are used to pull the heads to the front when work has to be changed. The four-stepped cones drive worm gear, by which the work is rotated, but the worm is provided with a friction clutch and releasing attachment, by means of which awkward shapes can be milled. (See figs. 12 to 15.) This machine is suitable for milling cams, links, small levers, glands, squares, hexagons, etc., used on steam and water fittings.

The machine shown in fig. 10 has been specially designed for milling the cams of motors and similar work, when the cams are solid with the shaft, or loose.

The piece is held in a three-jaw self-centring chuck, which grips the shaft on its journals or turned parts. The portion operated upon is close to the chuck, and the job is still further supported by a steady. The former plate is immediately behind the chuck, and the whole is revolved against the cutter by worm gearing. The bracket at the extreme right supports the end of the shaft, and is provided with a division plate to ensure the different cams along the shaft being in the correct relation to each other. After each cam is milled, the chuck is opened, and the shaft slid through the hollow spindle

far enough to bring the next cam into position. The bracket at the extreme right slides with the cam shaft, the dividing plunger being withdrawn before the feed motion is started. The cutter is carried in a head which slides to and from the bed at the back. The tracer roller is mounted upon it, and is kept up to its work by a weight and chain. A hand lever at the front withdraws the cutter from the work while a change is being made. For milling loose cams a short mandrel is fixed to the former plate in place of the chuck. The bed of the machine rests on a sud tray, and a pump is provided.

The vertical profile milling machine in fig. 11 is another speciality of Messrs. Webster and Bennett. In its essential mechanism it resembles the horizontal machine, fig. 9, but the work head is made to slide on a vertical bracket instead of on a horizontal bed. Its value lies in the tooling of pieces that lie outside the range of the horizontal machine. The work is fastened to a cam plate carried on the end of a large hollow spindle, through which a bolt runs for securing the mandrel in the spindle end. The various movements—circular, vertical, and trip—are controlled by adjustable dogs. The slide which carries the spindle is counterbalanced.

The sketches (figs. 12 to 15) will serve to illustrate the many and varied pieces which are dealt with on these machines, and the method of their operation. Figs. 12 and 13 show a cycle-fork crown attached to the cam plate, and just commencing its revolution in the direction of the arrow, the cutter, of course, running against it. The cam plate is held against the roller by the weight in the ordinary manner until the position at fig. 14 is reached. At this point the cam is assisted by a roller at the rear

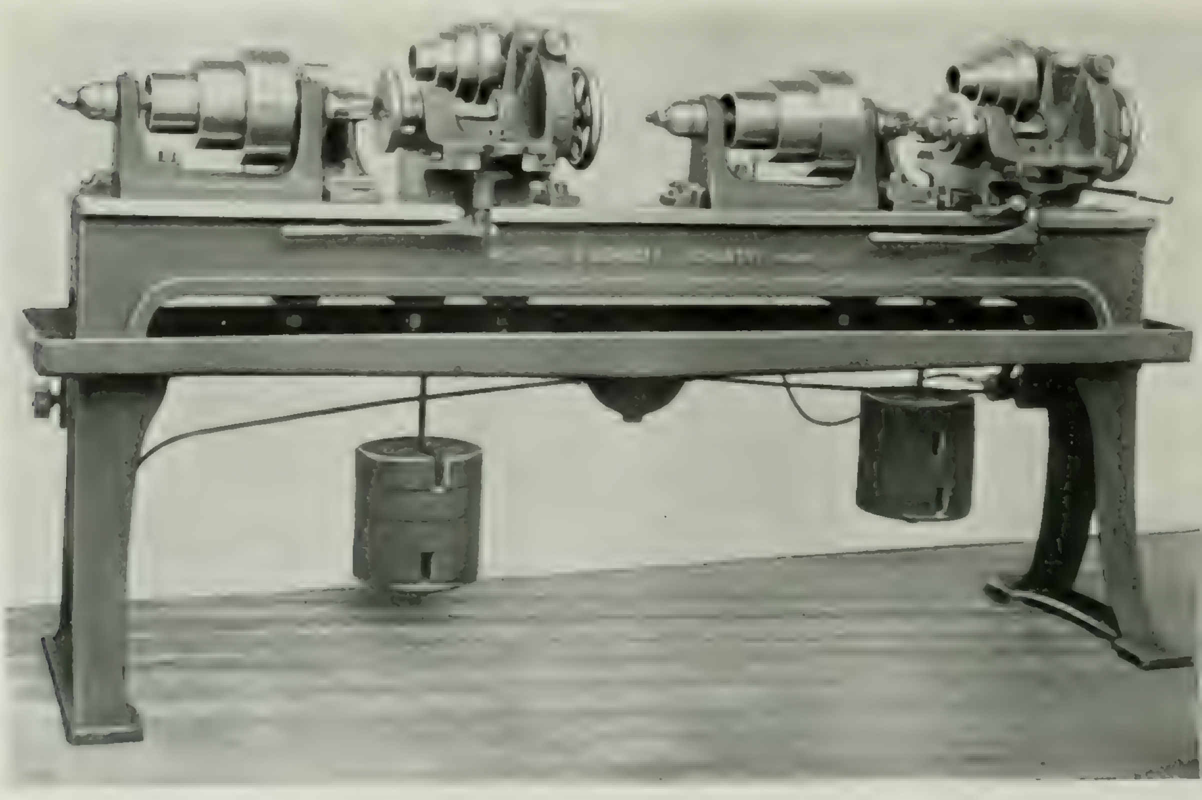


FIG. 9. DOUBLE-HEADED HORIZONTAL PROFILE MILLING MACHINE. WEBSTER AND BENNETT, COVENTRY.

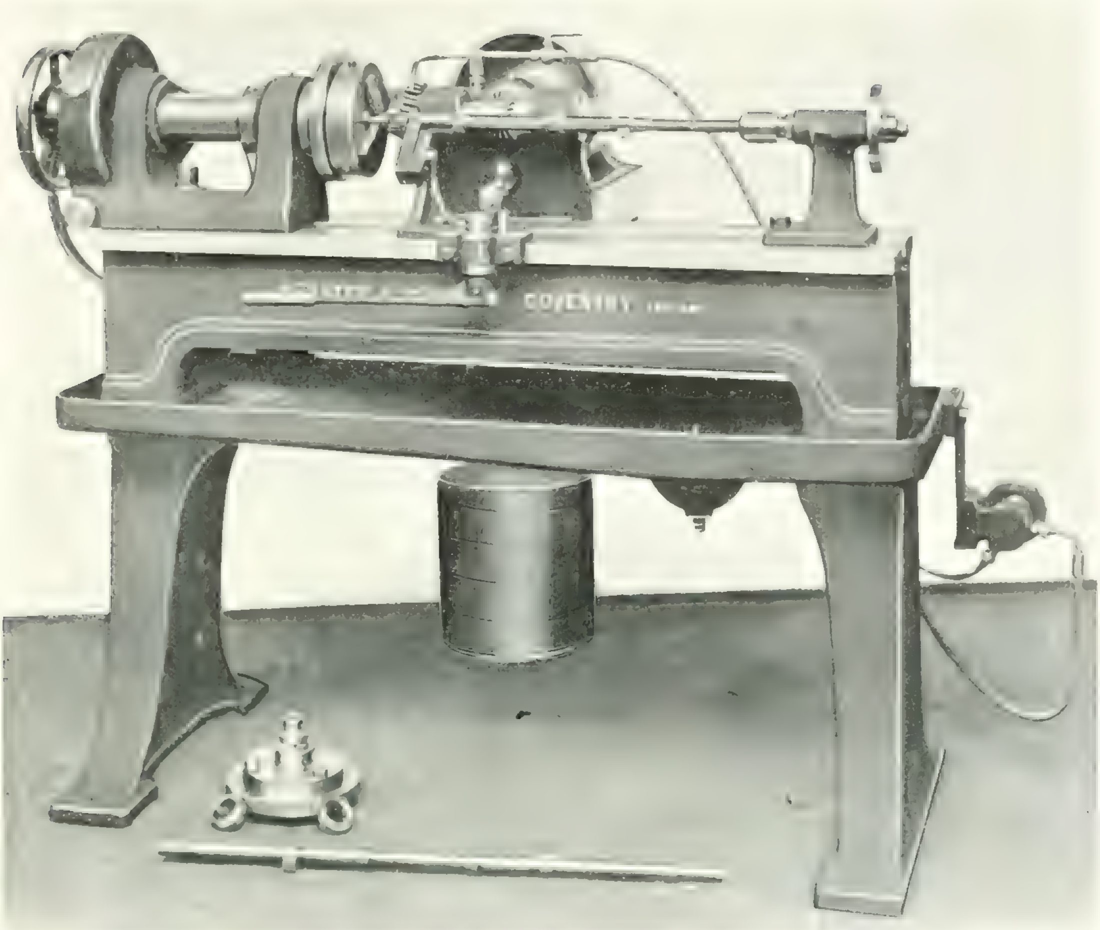


FIG. 16. MOTOR CAM SHAFT PROFILE MILLING MACHINE.
WEBSTER AND BENNETT, COVENTRY.

of the automatic head. Its action is shown in fig. 15. An inclined bracket is bolted to the bed, against which the roller pushes, with the result that, as the bracket cannot move, the whole head is pushed over bodily in the direction of the arrow. This, of course, draws the cam out of its awkward position—shown in fig. 14—and allows it to proceed on its revolution. This action occurs twice in each revolution, the large worm wheel being mounted on a friction cone, to enable it to slip slightly in the operation, the lost motion being taken up in a division plate, the small holes of which are indicated in fig. 15.

MODIFICATIONS IN DESIGN.

Many profiling machines have heads without any range of vertical movement, the only movement available in this direction being that imparted to the spindle itself by the hand lever. In the smaller machines of the pillar and knee type, the knee supplies the means for increasing the vertical range. In the heavier machines of the planer type the cross rail can be raised and lowered on the housings. So that in the heavier and the lighter machines we have two entirely distinct arrangements for increasing the capacity of these machines to suit work of different heights. In an intermediate class, in which the machine is usually carried on a cupboard base, and which supports the table slides, the cross rail, though frequently rigidly fixed with the housings, is also sometimes made movable thereon, as in the planer type.

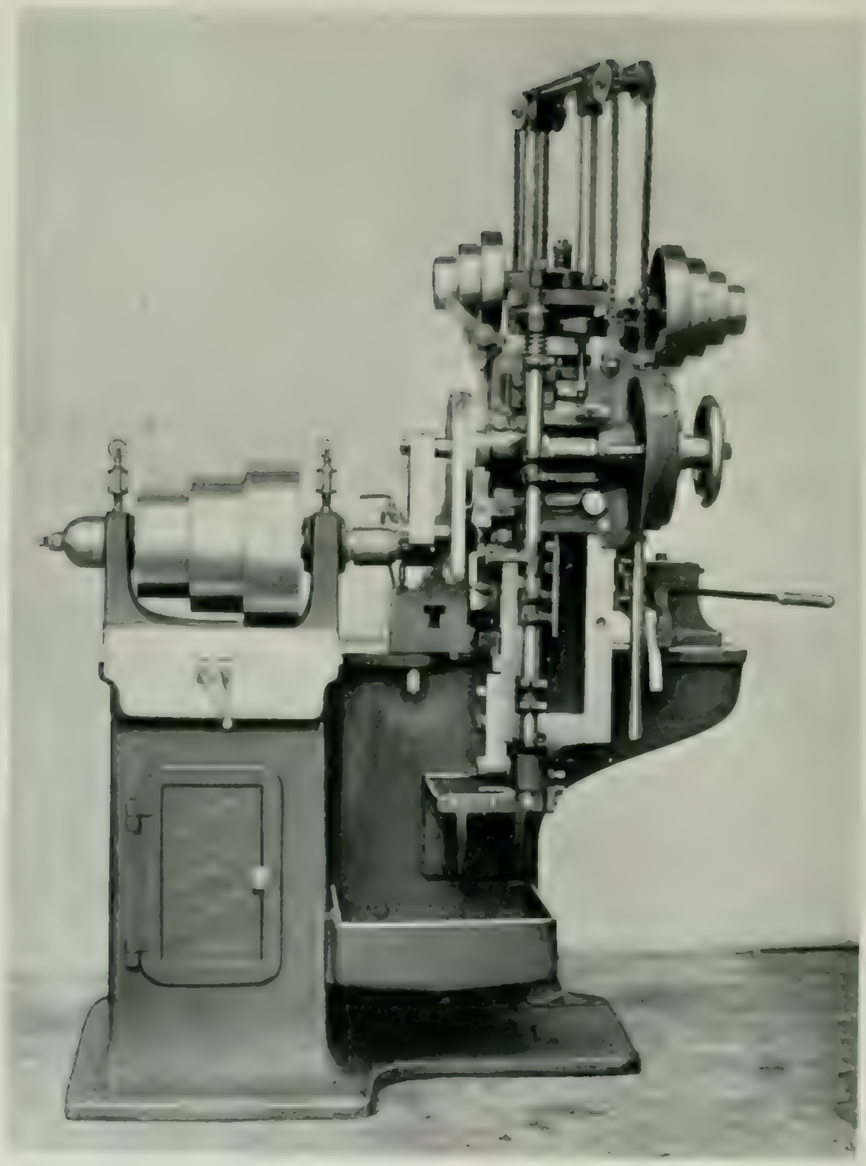


FIG. 15. VERTICAL PROFILE MILLING MACHINE.
WEBSTER AND BENNETT, COVENTRY.

Figure 16 illustrates a large profiling machine of the planer type, by Messrs. Kendall and Gent, of Manchester, which, of course, is equally suitable for plain and circular milling. The feature to be noted in this machine is that the spindle is not driven by a belt from a drum at the rear, but through toothed gearing, a practice which is adopted in a good many of the heavier machines.

THE WESSON DRIVE.

The belt difficulty in profiling machines, where the position of the head is constantly changing, is obviated by the recently patented Wesson drive. It is applied to the machines of the Garvin Machine Company, represented in England by Messrs. C. W. Burton, Griffiths and Co., of Ludgate Square, E.C. The essential feature is that the profiling spindle, or

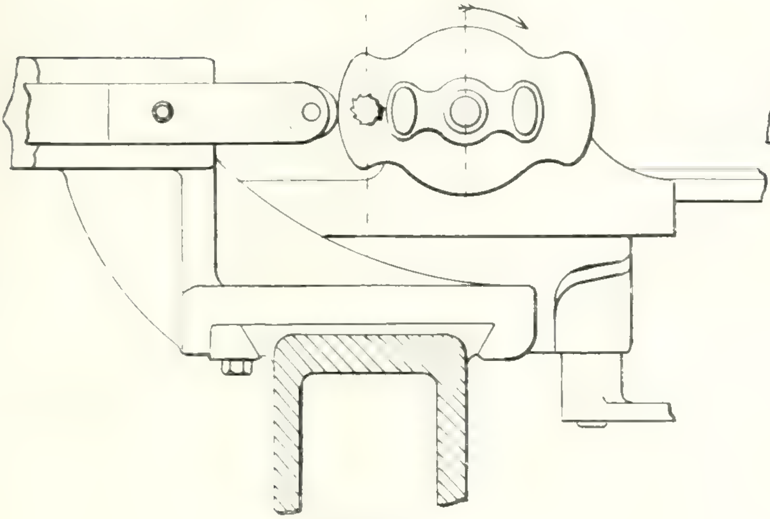


FIG 12.

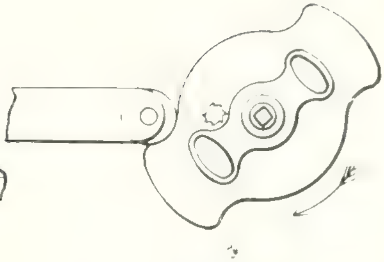


FIG 14.

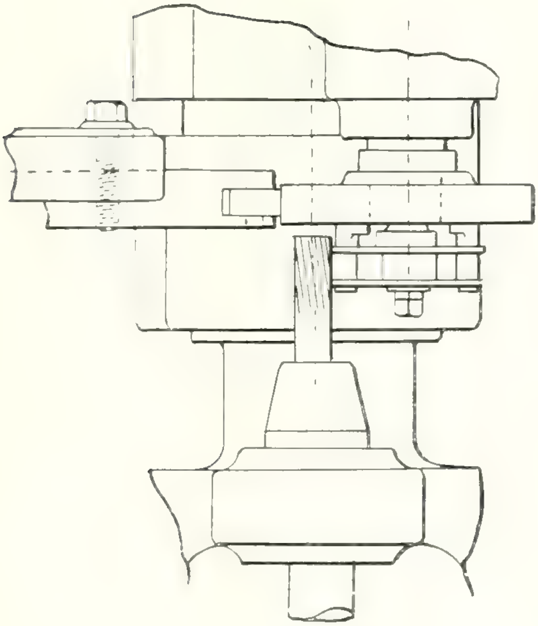


FIG 13.

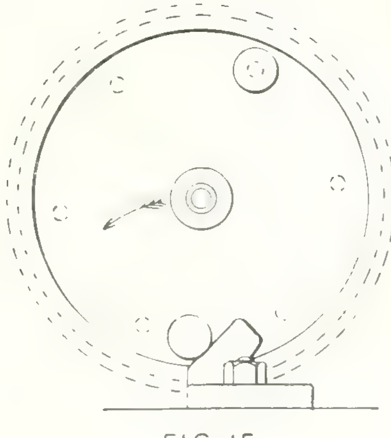


FIG 15.

spindles, are driven directly from the counter-shaft by telescopic shafts. One of the two-spindle profilers made by this firm, fitted with the drive, is shown in fig. 17. The telescopic rods which come down to the top ends of the spindles are made to suit the height of the ceiling of the shop. The countershaft is of a special type. A single casting carries the whole of the pulleys. A three-speed cone pulley, with an internal friction clutch, is belted from the main line shaft. Two pulleys on the cone shaft drive two small flanged pulleys on vertical shafts, which are jointed to the telescopic spindles. The direction of rotation of one or of both spindles can be changed by sliding the hinder pulleys sideways, and reversing the belt. The weight of the telescopic spindles is taken on roller thrust washers. The joints are fastened to the spindles and shafts with keys, secured by taper pins rivetted over at both ends. The joint pins are tapered, and secured by lock nuts. In the centre of the pin block there is a hole which contains felt, kept saturated with oil, which is driven out to the pin by centrifugal force, and so lubricates the joint.

THE GARVIN MACHINES.

Apart from this interesting drive, which obviates much of the vibration caused by belts, and does not block the light so much in the shop, the Garvin machines possess several good points.

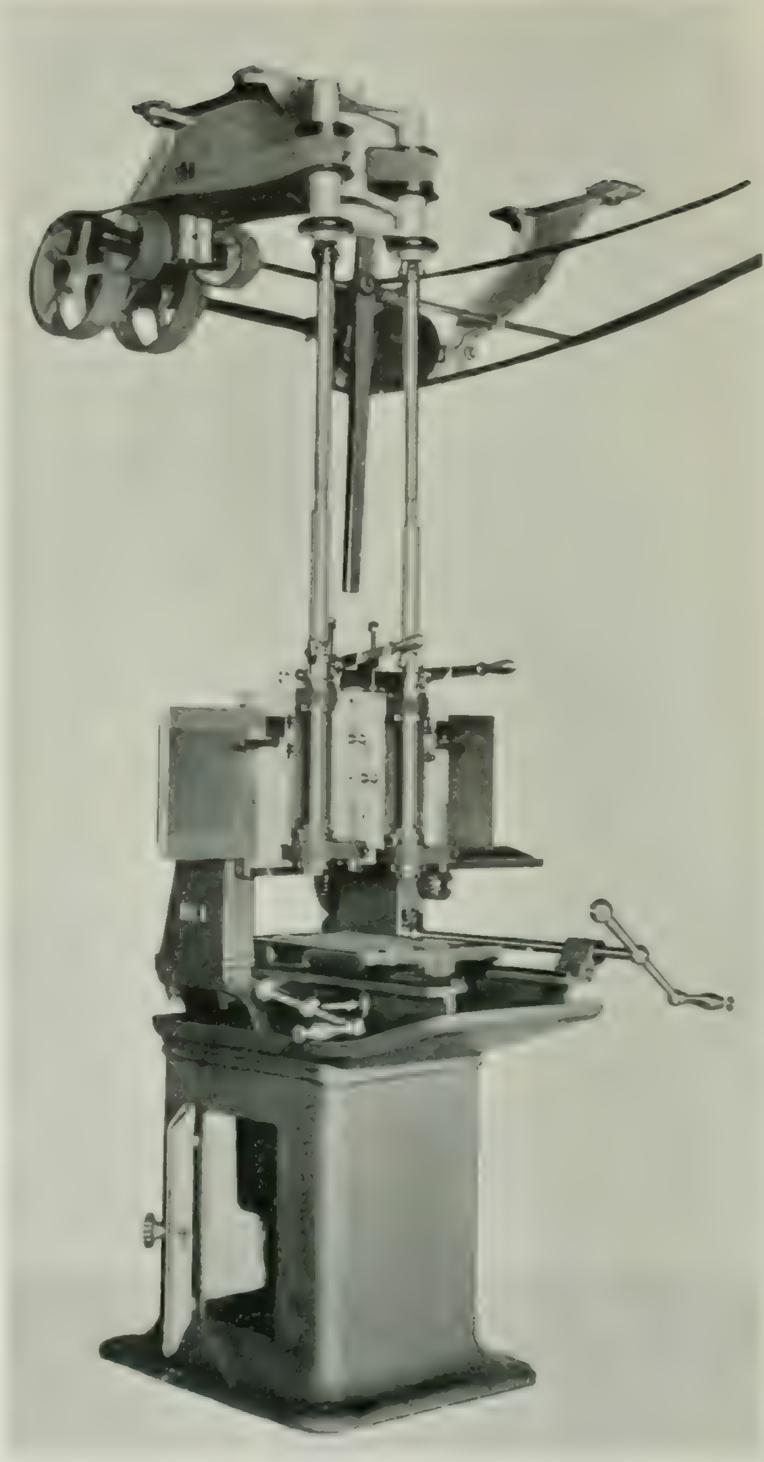


FIG. 17.—GARVIN TWO-SPINDLE PROFILER WITH WESSON DRIVE.

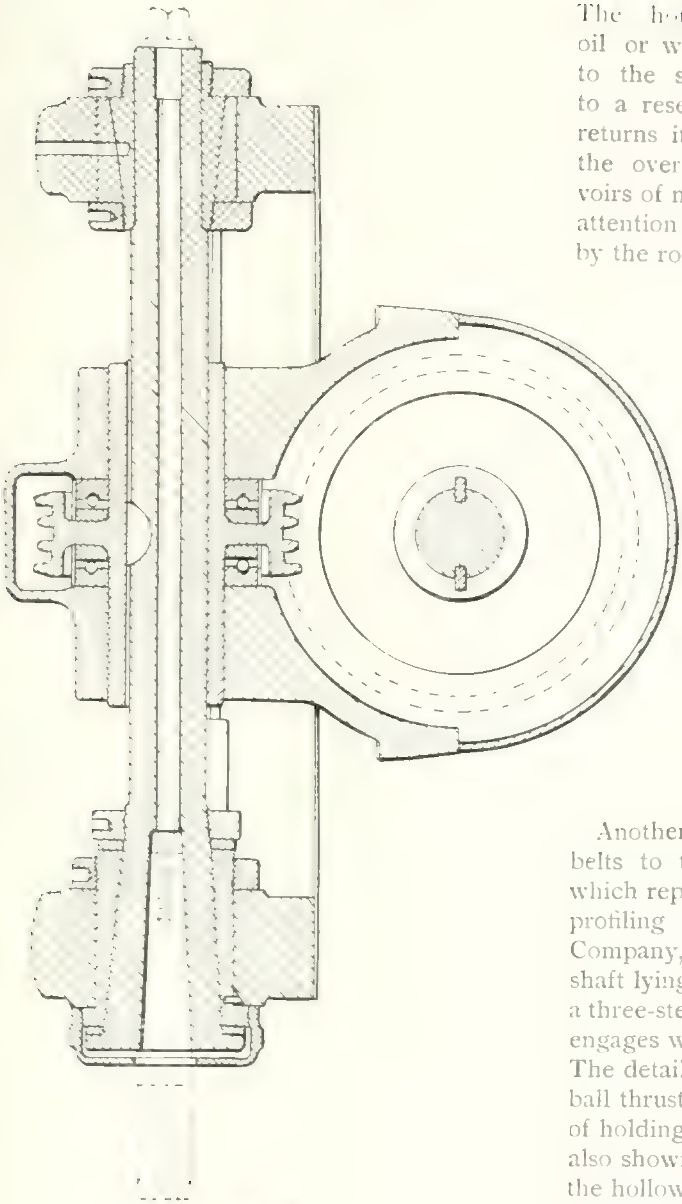


FIG. 18.

The housings are utilised as reservoirs for oil or water, and flexible pipes lead thence to the spindles. The lubricant is led back to a reservoir in the base, whence a pump returns it to the housings. The hangers in the overhead are supplied with large reservoirs of non-fluid oil, which lubricates without attention for a long time, and is not thrown off by the rotation of the shafts. A large oil groove round the table keeps grit off the slides. The spindle slides are balanced. They have adjustable lock tops, micrometer adjustments, and screw gauge stops. Stops are fitted to the table movement, and back lash is taken up on the pinion and rack that drives the table. The lever usually employed for controlling the movement of the cross slide is replaced by a crank handle and gearing, giving the operator greater command over his work, with less effort on his part.

THE NEW PRATT AND WHITNEY SPINDLE DRIVE.

Another recent drive, which does away with belts to the spindle, is illustrated in fig. 18, which represents the spindle of a double-spindle profiling machine by the Pratt and Whitney Company, of Hartford. A horizontal splined shaft lying along the cross rail, and driven from a three-stepped cone, carries a spiral gear, which engages with a similar gear on the cutter spindle. The details shown in the drawing, including the ball thrusts, are self explanatory. The method of holding in the taper shanks of the cutters is also shown dotted, a long bolt passing through the hollow spindle, in the manner common to light machines.

WORKSHOP PRACTICE

A RÉSUMÉ OF MACHINE TOOLS, CRANES, AND FOUNDRY MATTERS FOR THE MONTH.

MACHINE TOOLS.

WE illustrate one of the Milwaukee milling machines, for which Messrs. Schischkar and Co., Ltd., of Birmingham, are the English agents. A general idea of the design can be gathered from the photo (fig. 1), while the heavily shaded portions in figs. 2 and 3 show the vertical spindle, and the rack cutting attachments. The machine is interesting as representing high-class American practice by a firm who offer a welcome to all visitors, and who work only in specialities.

The headstock is curved upwards at the rear of the pulleys, in lathe head fashion, and is braced at the top by a continuous boss, which receives the overhanging arm. The arm and knee are connected with cross braces, which are readily removable. The knee is of the box section. Feeds are automatic, in longitudinal, transverse, and vertical directions, and only one can be engaged at one

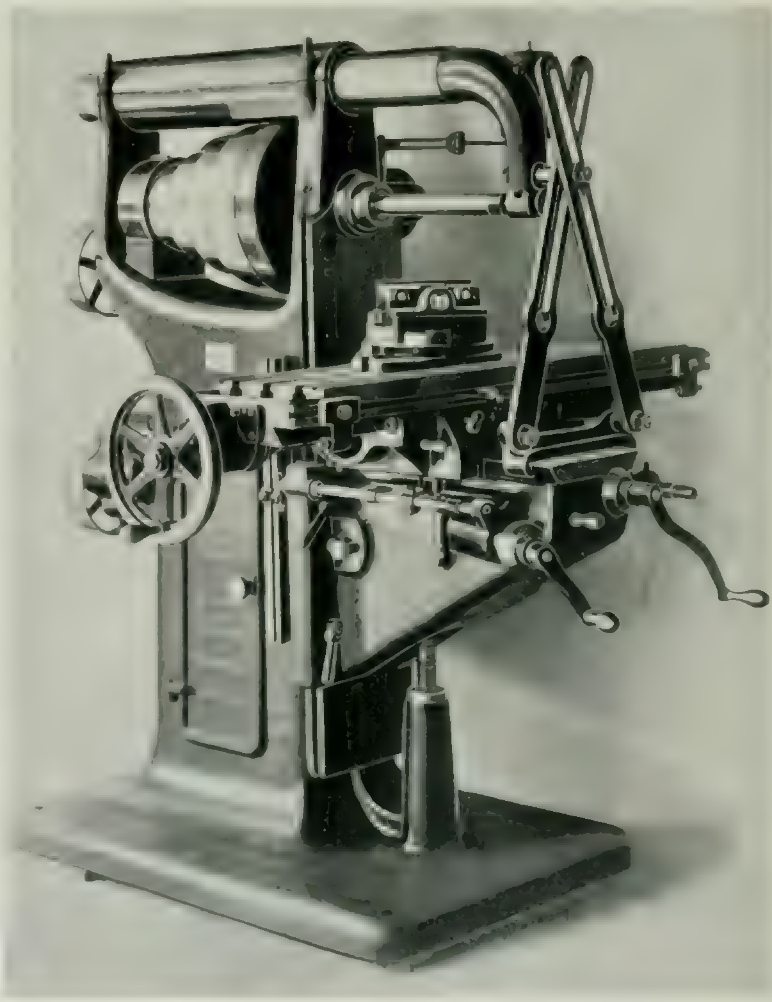


FIG. 1. NO. 2 PLAIN "MILWAUKEE" MILLING MACHINE.

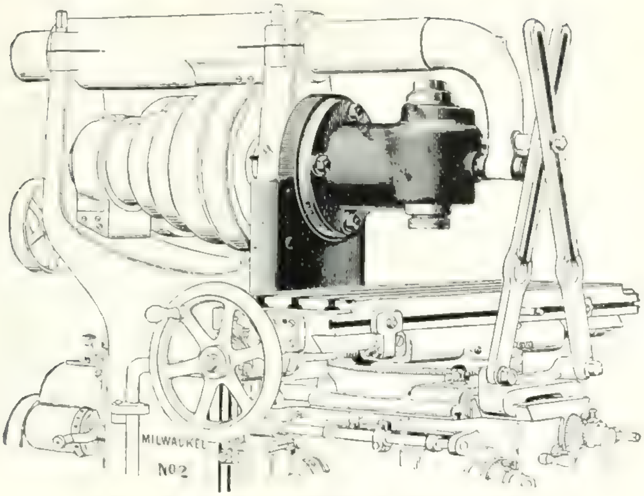


FIG. 2. VERTICAL SPINDLE ATTACHMENT.

time, the other two being automatically locked. The feeds, twelve in number, range from ·006 in. to ·13 in. per revolution of the cutter spindle. They are controlled from a box at the rear of the machine by simply moving a lever over a dial plate, and without the employment of stepped cones. The headstock spindle has a taper hole to receive a No. 10 B. and S. taper shank, and the nose is threaded, and protected by a collar when not in use. The spindle bearings are of bronze.

In the universal machines, the spindle of the spiral head has a taper hole and threaded nose to correspond with that of the main spindle, so that all fixtures will interchange. The back centre is adjusted vertically for tapered work by means of a rack and pinion. It is graduated in degrees, to correspond with the graduations on the head, so that it is possible to set the tail centre in line with the spindle on the head instantly. The swivel carriage has a graduated circular base, and can be clamped at any angle. The thrust of the elevating and table screws is taken on ball bearings. The feed screw has compensating nuts, and all vital parts subject to wear have means of adjustment. The screws have micrometric dials, reading to thousandths of an inch.

The vertical-spindle attachment (fig. 2) is used with the arm brace still in service, so that heavy cutting is readily done. The spindle can be set to any vertical angle, and clamped there by means of the nuts in a circular tee-groove on the face of the head. The edge is graduated into degrees.

The rack-cutting attachment (fig. 3) is bolted to the same face as the vertical-spindle fitting, and is also supported by the overhanging arm. Room is left for the fitting of several cutters set parallel with each other for cutting teeth in a rack simultaneously. Spiral gears can be cut with the universal head and swivel table. In many cases a circular saw is inserted for cutting stock off to length.

NEW LATHE BY MR. GEORGE ADDY.

The photo illustrates a new electrically-driven pipe-turning and boring lathe by Mr. George Addy, of the Waverley Works, Sheffield. It is designed for dealing with pipes ranging from 10 in. to 30 in. diameter, by 12 ft. 6 in. in length. The tool is of large dimensions, weighing 15 tons, and is a striking illustration of a highly specialised machine.

Both heads are driven independently, each by its own motor, which is of the four-pole type, and therefore slow running. Instead of using a worm drive, the rotation of the motors is transmitted to the headstock gears through a pair of

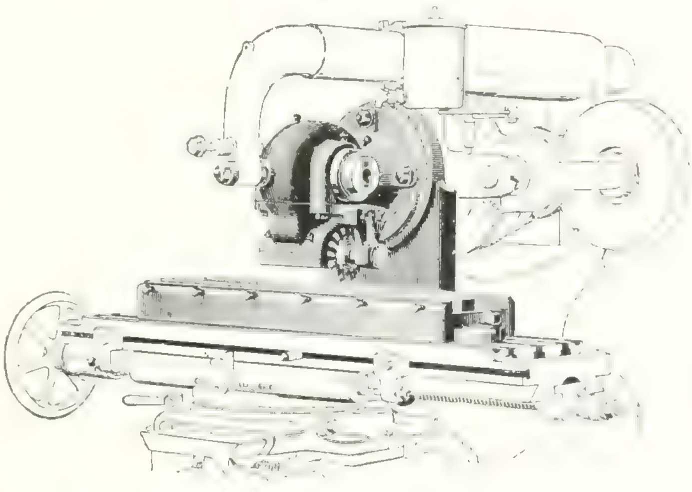
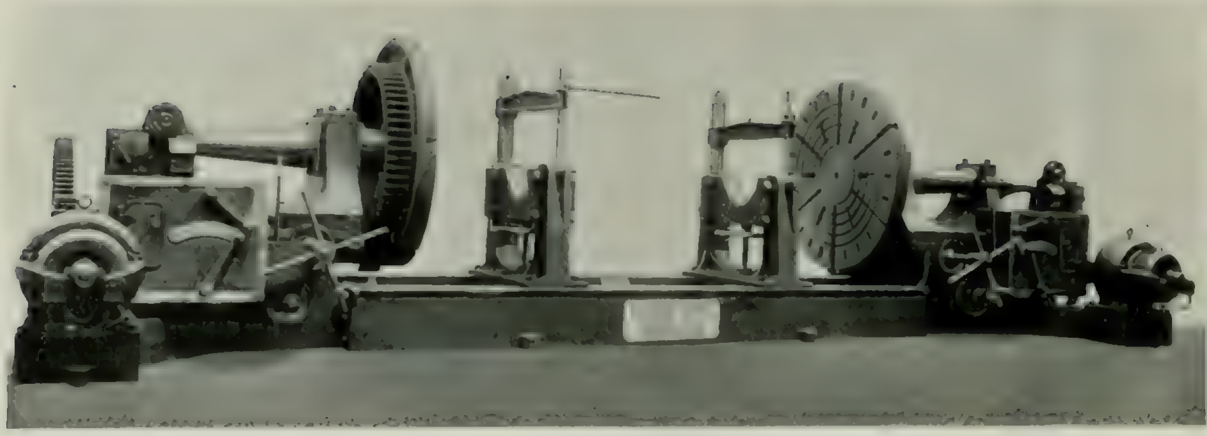


FIG. 3. VERTICAL SPINDLE AND RACK-CUTTING ATTACHMENT.



ELECTRICALLY-DRIVEN PIPE-TURNING AND BORING LATHE. MR GEORGE ADDY, SHEFFIELD.

bevel wheels. The mechanism of each head is alike, so that a description of one will apply to both.

Each of the boxes seen in front of, and below, the main spindles of the headstocks, contains a nest of spur gears. The headstocks are double geared, but the back gear, placed below, is always in engagement, and variation of speed is obtained by the nest of spur wheels just mentioned. In each box there is a bottom shaft which can be slid longitudinally, and a top shaft which has no endlong motion. These shafts carry gears, and the bottom one a sliding key, by which either one of three wheels, each of a different size, is brought into engagement by the movement of the lower lever seen in front of the box, so changing the speed of the spindle, in addition to the changes afforded by the regulating switch above the box. The upper smaller lever controls the feed. This is attached through worm, bevel, and spur gearing, to a screw underneath the headstock. This can be stopped instantly by the long lever that stands up on the inside of each box, and which controls a positive clutch.

The three switches seen above each gear box are as follows. The one at the extreme outer end is the starting switch, the one above is the speed-regulating switch, or controller, and the inner one is a double-pole switch used when stopping the motor. This switch breaks the current, and so avoids having to tear the magnetic switch from its attraction; consequently it moves back as soon as the attraction has ceased.

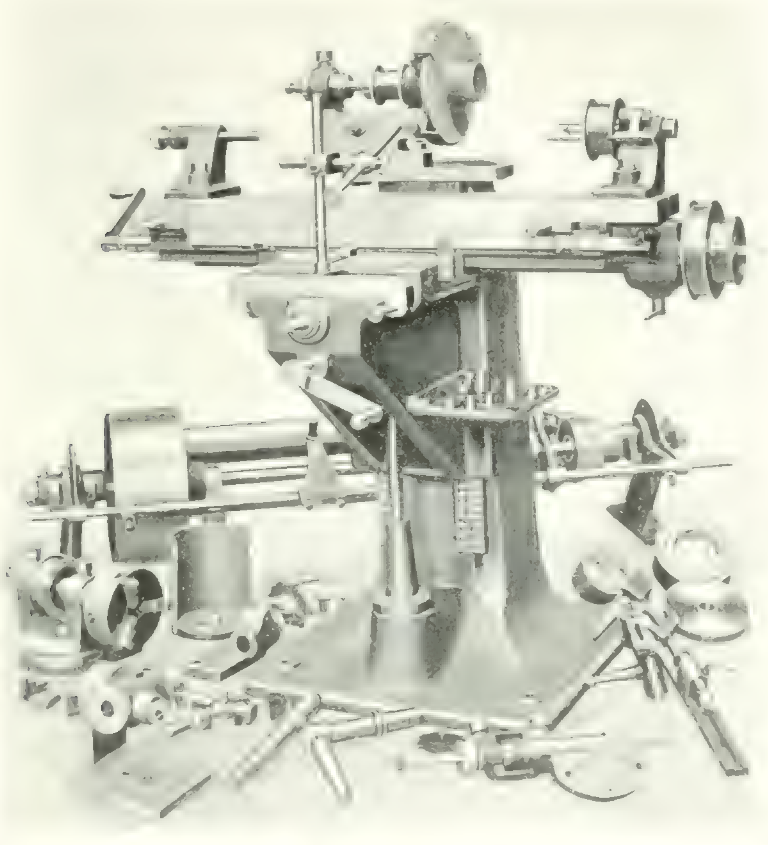
The absence of a slide rest from this type of lathe is explained by the method of turning and boring adopted in pipe work. Cutter rings are bolted to each face plate, one of which turns the external diameter of one end of the pipe, while the other bores the internal diameter of the other end. Each headstock advances by the screw feed just now mentioned, towards the centre of the bed, until each end has been turned and bored to the required length. The face plates are grooved, so that the boring and turning heads can be bolted into position easily. The pipe rests or steadies are interesting pieces of mechanism, comprising fine screw adjustments for centres. The spindles run in bearings of gun-metal.

CRANES.

A correspondence which has been going on in a contemporary relative to electric cranes affords a striking commentary on the weakness of dogmatic assertion. Two firms, both thoroughly reliable, and fully conversant with the best modern methods, differ widely on a question of efficiency. The writer knows the works of one ot these firms very well, and would be prepared to swear by any statements which they should make, so carefully are all experiments conducted there, and of so high a grade is the workmanship put into their cranes. But the point is this—experiments which are conducted

in different works are not exactly comparable with each other, and the results that are obtained are very largely affected by little details of workmanship, and by local shop conditions, which are often of much greater importance than the mere calibration of instruments used in tests. Practical men will quite understand how this can happen. The writer holds that mere statements of results obtained in different shops are of little value.

cranes. It is true that in a vast number of cases ropes have been taken out, and the cranes converted into electrical ones, with economical results ; but in a large number of instances the rope cranes never had the chance to develop their fullest possibilities, the reason being the neglect of those precautions which experience has shown are necessary to yield the best results from the system. There is nothing perhaps more responsive to frictional losses than a high-



UNIVERSAL GRINDING AND FINISHING MACHINE. THE LONDON EMERY WORKS COMPANY.

It is much to be desired that the whole subject of electric *versus* rope cranes should be settled in one shop on the same overhead crane, or on two cranes of similar make, fitted with motors and ropes respectively. The subject is one of much practical interest. Even now, though so many cranes are motor-driven, there are firms who still retain and prefer the rope drive, and a good business is still done in these

speed rope running over a number of pulleys. If the rope is of unsuitable material, badly made or badly spliced, if the pulleys are small and not true, nor hung truly, nor of proper section, if the jockey weight is not properly proportioned, if bends are sharp, or speeds too high, the efficiency of the rope is greatly lessened, and excessive power is required to drive it. But in any case it is a rope drive.

The subject is one of more than passing interest, because the choice of power for overhead travellers is now almost entirely restricted to ropes and electric motors. The steam traveller, except for outdoor service, for which it is often very suitable, is being used less and less, while the square shaft system has many fatal objections, and is being abandoned rapidly.

FOUNDRY MATTERS CUPOLA PRACTICE.

In England, cupola practice has not advanced so much as it has in America, nor, probably, as much as in Germany, that is if it is to be gauged by the employment of patented and improved types. In this respect the English foundryman is conservative. And yet it is open to question whether the results obtained in English foundries with common cupolas are not as economical as those obtained with the more scientific types. Of course, a very big factor always is the length of a melting, but beyond this the writer holds that almost everything depends on the skill of the melter. It is not only possible to put good iron and good coke (both ideal from the chemist's point of view) into the cupola, and obtain very bad metal, but one man will also get hot clean metal with a very much lower expenditure of coke than another. All the patents—and they are legion—which have been taken out for arrangements of tuyeres, only embody those principles with which the intelligent melter is familiar, viz., that the blast must be evenly distributed through a certain zone of the cupola, which occupies a well-defined vertical position, above and below which complete combustion and melting do not go on. Any common cupola of good height, and, with a good arrangement of tuyere holes, is capable of melting economically, if used with intelligence by a man of experience. A good bed charge is necessary, after which a comparatively small quantity of coke need be used.

A good furnaceman is therefore a valuable acquisition in a foundry, and his wages should rate as high as those of a skilled mechanic. There is no time to idle after the metal comes down, but the melting zone must be constantly watched to see that a sufficiency of fluid iron is dropping, and the necessary instructions given for re-charging. A knowledge of chemistry alone will not ensure good results, though it helps a man in understanding the reasons for some of the phenomena which he observes daily, and is thus a valuable ally to practice.

UNIVERSAL TOOL GRINDER.

The illustration shows a universal grinding and finishing machine, with automatic longitudinal movement of table, of substantial and high-class manufacture. It is by the London Emery Works Company, of Clerkenwell, E.C. Articles which have to be ground to gauge can be handled with facility on this machine. The fitting of an automatic travel to the table gives better results than in those machines with hand travel produced by means of a crank handle. In grinding milling cutters the table does not travel the exact length of the teeth, but a little further, so that the operator has time to bring another tooth into position before grinding. Should it be necessary to work the table by hand, as is sometimes the case, the clutch on the table is brought into gear in its middle position, thus releasing the automatic feed. If the reversing pin is tightened, the return stroke can also be utilised. The grinding head is fastened to the stand of the machine and is adjustable, and either an emery wheel or a cylinder can be used. Both types are protected by a hood, to which an exhaust pipe, to draw off the dust, can be easily fitted. The machine is driven from an overhead motion, having an oscillating saddle, which gives automatic motion to the table; and the adjustment is accurately balanced with a counterpoise, so that the belting always remains taut.

The height of the machine to the centre of the spindle is 44¾ in., the longitudinal movement of the table 23⅝ in., the traverse movement by hand 9 in., and the vertical movement, also by hand, 15¾ in. The extreme length taken between centres is 24½ in.

NOTES & NEWS.

[illegible]

[illegible] H.M.S. [illegible] Dock Company, [illegible] at Singapore.

COALING H.M.S. "TERRIBLE."

Some 1,510 tons of Cardiff coal were loaded into the *Terrible's* bunkers in 5 hours commencing at 10.7 a.m. and finishing at 3.7 p.m.—a record performance. The *Terrible* was coaled during the hottest hours of the day, the temperature in the shade being 88·3°.

Notes and News.

10,000 Volts Three-Phase Transmission in Algeria.

[illegible] Oued-Fekan.

THE [illegible] private lighting of the town of Mascara, which is situated about sixteen miles from the power station, and also motive power to the Mascara central pumping station, established at Side-Daho, about twenty miles from the falls.

[illegible] shillings a ton at Mascara, and as water is also scarce, the use of steam power was practically out of the question.

A dam had to be made to retain the water at the necessary level, and its construction presented greater difficulties than all the rest of the undertaking, due to the fact that Algeria is frequently visited by terrible storms. The first dam was, in fact, swept clean away by one of these floods, and therefore the second dam has been built to withstand ten times the normal pressure. It is carried on immense concrete foundations sunk into the bed of [illegible] with cement.

The head race, which commences at the dam, is about 2,000 yds. long, its width at the top being 4 ft. 2 in., and at the bottom 2 ft., and its capacity 18 cubic feet per second. It is concreted throughout its whole length, and ends in a reservoir provided with an overflow outlet. From this reservoir a steel pipe line about 400 ft. long runs to the turbines.

This pipe line is of rolled steel in lengths of 20 to 30 ft. each, and jointed on the Gibault system. The internal diameter is 2 ft. $3\frac{1}{2}$ in., and the minimum capacity about [illegible]

The effective height of the fall is 150 ft., and, in order to economise in the pipe line, the thickness of the pipe is [illegible]

[illegible]	[illegible]	for	45	lb.	per	square	inch
80 ft.	[illegible] in.	„	[illegible]	„	„	„	„
120 ft.	$\frac{1}{4}$ in.	„	[illegible]	„	„	„	„
145 ft.	[illegible] in.	„	135	„	„	„	„

Some of the piping is supported by iron rings fixed to massive blocks of freestone placed at convenient intervals;

[illegible]

the rest is carried on tarred wooden beams so arranged that the pipe is raised a few inches above the ground.

The power station is on the left bank of the river, at a sufficient height to ensure its being above the water level during the heaviest floods. The building is 40 ft. long and 35 ft. wide. The foundations are made of hydraulic cement concrete being also used where the presence of water necessitates this construction.

The available power amounts to about 200 h.p., and two electric generating units of corresponding output have been installed, one of them being a stand-by.

The turbines are by the firm of Negret, Bremer and Co., of Grenoble, and are of the horizontal shaft type. They are constructed for a head of 130 ft. and 20 cubic feet of water per second, and develop 192 to 200 h.p. at 500 revolutions per minute. The efficiency is 80 per cent. at full load and 72 per cent. at half load, a special turbine regulator being provided, which maintains the speed constant within two or three per cent.

The three-phase generators are of the International Electrical Engineering Company's (London) standard type, having a stationary armature and revolving field magnets, the poles (each having its own coil) being interior to the armature core. Each alternator is capable of developing 125 kilowatts at 530 volts and 50 periods per second, when running at 500 revolutions per minute. It is complete with a direct-driven exciter, and the couplings between the turbine and the alternator shaft are of the flexible type.

It may be mentioned that it was decided to generate the current at 530 volts, and to transform up to 10,000 volts, because the construction of the generators and also the switchboard is so much simplified.

Although one of the generating sets is usually held in reserve, the connections are such that both sets can be run in parallel, as, for instance, in changing over from one set to the other without stopping supply.

The transmission line consists of three bare copper conductors, each 0·3 square inch cross section. The poles are of cedar wood, 40 ft. high, and are spaced 30 to 50 yards apart.

At both ends and every 550 yards along its complete length, the line is protected by "Siemens'" lightning arresters, fitted with high-tension cut-outs

Guard netting is employed where the line crosses the railway and the public highways. This netting is in the form of a metal cage, and it is impossible for a broken line wire to fall to the ground. Here and there conspicuous notices in both Arabic and French have been placed on the poles stating that contact with the line is fatal. A telephone line connects the generating station with the Mascara and the Side-Daho pumping works.

The receiving station at Mascara consists of an underground vault, containing four 40-kilowatt transformers, the secondary and feeder switchboards for the town lighting supply. A freezing machine has also been installed to make use of the surplus power which is available during the day time. It is on the Douane system, and is capable of producing 270 lbs. of ice per hour.

The Development of Eastern Peru.

The Camino de Pichis is a bridle-road, which is intended to serve as an outlet for the produce of a region on the eastern side of the watershed of the Andes, to which the Peruvian Government wish to attract immigrants, and is a part of the "Via Central" or "Central Route" of Peru.

This route, taken together with the navigation of the River Amazon, reaches from the Pacific to the Atlantic; but, in its present state of development at least, is not intended to afford through communication.

The upper, or western, part of the region to be developed is the hilly country, from which are derived several streams flowing into the Ucayali, chiefly those which do so as affluents of the Pachitea. This hilly part lies mostly above seven hundred metres of altitude, and

the road itself rises above twelve hundred metres, [illegible] sea level. The more eastern part of the road traverses an almost level region, the banks of the Azupizu, and runs alongside that stream, and the River Pichis to Puerto Bermudez, at the confluence of the Pichis and the Chivis, about twenty kilometres north of Port Tucker.

From Callao to Oroya is 220 kilometres by rail, the latter place being 3,712 metres above sea level. Thirty kilometres beyond by bridle-road is the town of Tarma with some 8,000 inhabitants (at an altitude of 3,054 metres). Seventy-eight kilometres further north-east is the already settled valley of Chanchamayo, with the village of La Merced, which has 600 inhabitants, and an altitude of 775 metres. Cocoa, coffee, and sugar-cane are cultivated in the valley.

Thirty-four kilometres further on, and 117 from Oroya, the "Camino de Pichis" begins at the little village of San Luis de Shuaro (861 metres). This road traverses the region now advertised by the Peruvian Government, and is 221 kilometres in length, traversing a wild region which has entailed the provision by the Government of some dozen inns to provide food and shelter for the pack animals and their drivers. About 114 kilometres are in the hilly region, and the remainder in the flat land. From Puerto Bermudez, the end of this road, the journey is made by steamboat down the Pachitea and the Lower Ucayali, fifteen hundred kilometres, to Iquitos, on the Amazon, a port which ocean-going steamers can reach.

It is not quite clear whether a transhipment is necessary between Puerto Bermudez and Iquitos; if so, it could easily be avoided in the future.

The products which the "zone of the Pichis" provides or is adapted to provide, include timber, rubber, resins etc., cocoa, coffee, coca, and sugar-cane.

The journey from Lima to Iquitos is supposed to take seventeen days, the return journey being made in twenty-two days.

It should be clearly understood that this is not a through route, nor is it at present worked regularly, since the Peruvian Government, in their official guide, give the sea route, by the straits of Magellan, as the way to reach Peru from the coasts of Brazil.

This enterprise shows some activity on the part of the authorities in Peru, and the great natural wealth of the country, the remarkable extent and nature of the great waterways concerned, and the importance of some of the products of that region deserve some notice from those who are accustomed to keep an eye on the less exploited regions of the world.

Enterprise and Technical Education.

Messrs. Handyside, makers of steel bridges, roofs buildings, etc., of Derby, in order to encourage their apprentices, have arranged to pay half the fees, and purchase the necessary instruments and books, for all their apprentices who attend evening classes at the Derby Technical College, in approved subjects, for a term of three years. Apprentices who pass the prescribed examinations, will receive increased wages, and will be allowed to retain the instruments purchased for them.

In a letter to the *Times*, Mr. James D. Legard, Chairman of the Technical Instruction Committee, N.R., Yorks County Council, points out that some of the great ironmasters in Middlesbrough, and in the Cleveland district of North Yorkshire, have agreed to give their apprentices one day off in the week without counting it loss of time, and also to pay half their fees, to enable them to attend day classes in science. The county borough of Middlesbrough and the county council of the North Riding of Yorkshire have agreed to pay the other half of the fees of these pupils, who therefore are able to get this instruction free. The classes have been established by the governors of Middlesbrough High School, and are held throughout the year. The subjects of instruction include applied mechanics, practical mathematics, and steam.

It is observed that evening classes in these subjects have long been available, but it is found that after a long day in the shops, or the drawing office, a young man is hardly physically capable of taking advantage of this method of instruction. The present plan is in all ways preferable.

Successful Exhibits.

At the Düsseldorf Exhibition, the Lahmeyer Electrical Company, had some 15,000 h.p. of electrical plant running. We are informed that they received the highest award viz., the Large Gold State Medal and [illegible] Exhibition Medal, for their machines in almost every group.

D. Stewart and Co. (1902), Ltd.

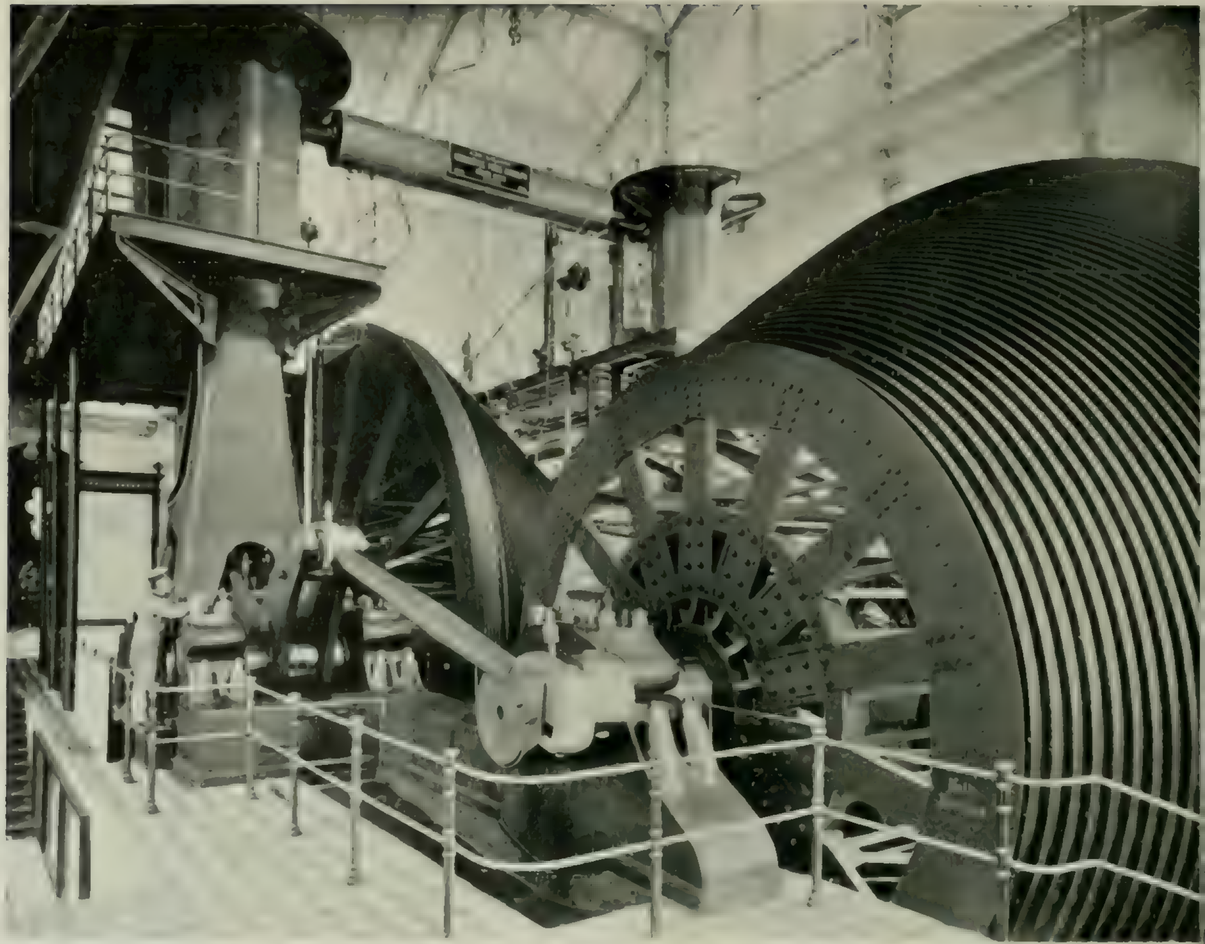
The business and works of D. Stewart and Co., Ltd., have been taken over, as at 9th June, 1902, by a new company, which has been registered under the title of D. Stewart and Company (1902), Ltd. Mr. William Beardmore, of Parkhead Forge, Rolling Mills and Steel Works, Glasgow, is Chairman of Directors.

A Notable Winding Engine.

The vertical winding engine shown in the photo was one of the most prominent exhibits at the Düsseldorf Exhibition. It was built by the Prinz Rudolf Ironworks Company, of Dulmen, for the Preussen II. colliery of the Harpener Bergbau Gesellschaft, and was designed by Dr. E. Tomson, the general manager of the Harpener Bergbau Gesellschaft. The spiral rope drums have their cones turned in opposite directions; this enabling the shafts to be kept to moderate dimensions. The engine is an inverted, vertical two-cylinder compound of the marine type, and is connected to the drums by unequal armed rocking beams and connecting rods, giving a crank throw of about two-thirds the piston stroke. The main dimensions are as follows:—

High pressure cylinder, 850 millimetres diameter by 2,600 millimetres stroke.

Low pressure cylinder, 1,150 millimetres diameter by 2,600 millimetres stroke.



VERTICAL WINDER EXHIBITED AT DUSSELDORF EXHIBITION.

Boiler pressure, 12 atmospheres.

Diameters of drums, 5,500 millimetres to 10,000 millimetres.

Total width of each drum, 3,500 millimetres; horizontal part, 350 millimetres wide.

Maximum winding depth, 1,200 millimetres.

Average winding speed, 10 metres per second.

With a rope speed of 12 metres per second the engine runs at 28·2 revolutions per minute, which equals a piston speed of [illegible] ft. per minute. The drum shafts are 650 millimetres diameter, with 500 millimetres journals, an overhanging weight being placed in the centre to counterbalance the reciprocating parts. The engine weighs in all about 470 tons, and covers some 70 ft. [illegible]

The loads the engine will have to wind from the [illegible] are as follows:—

[illegible] 8 [illegible] carrying 88 cwt. [illegible]

[illegible]	6	[illegible]	[illegible]
[illegible]	4	[illegible]	42

giving an hourly output of 180, 145, and 125 tons respectively, twenty seconds being allowed for decking. The pit-frame, some 100 ft. high, which is to be used with this engine, was also shown at the exhibition, and was built by the Humboldt Engineering Works Company, of Kalk. The cages weigh 4 tons, and the rope about 10 tons, giving, with eight loaded tubs, a load of 18 tons 8 cwt. from the bottom. The pit-frame has Tomson's improved method of changing all four decks at once on to hydraulic-balanced cages, these cages being discharged during the next winding.

New Destructor Plants.

Orders for a destructor plant, to deal with 120 tons of refuse per day, have been placed with the Horsfall Destructor Company, Ltd., by the Bradford Corporation. The same company is also providing destructor plants for Swansea and West Hartlepool, to deal with 75 and 60 tons respectively per diem. The West Hartlepool plant is an extension of the existing "Horsfall" destructor.

NAVAL NOTES.

MONTHLY NOTES ON NAVAL PROGRESS IN CONSTRUCTION AND ARMAMENT.

BY

N. I. D.

THE two questions of the greatest interest which have concentrated the attention of naval students during the past month are those which concern the share which the Colonies are prepared to take in the provision of Imperial defence, and the future training of the naval officer. With regard to the former, the proceedings of the Colonial Conference, which have now been issued, are full of the most interesting matter, some portion of which I propose to refer to here. On the other hand it is somewhat difficult to deal, except in the most cursory manner, with the second and equally important problem—that connected with the supply and training of officers for the Navy.

It is generally known at the time of writing that the Admiralty have in contemplation large changes connected with the entry and the co-ordination of the various branches of officers. It may be that the official scheme will be made public before these lines appear; for the present everything is a matter of conjecture and speculation. What we may be quite sure of is that the Board, with Lord Selborne at its head, will have given due consideration to the vastness and complexity of this question, so intimately associated with the future prosperity of the Navy and the Empire. We have heard a great deal about the grievances of the marine engineers, the officers in charge of the engineering department of the Navy. Other branches, too, have at various times voiced their aspirations and desires. We may rest assured that any scheme which has for its basis merely the gratification of such desires, or the remedy of such personal complaints, cannot be an adequate solution of the problem. What is wanted is something conceived in a more statesman-like frame, something showing a broad-minded grasp of the essential necessities of the nation's Navy. Such legislation must be, for the future, tempered by tactful treatment of existing personal and professional feelings and sentiments. A common entry (preferably by nomination), a common educational basis of culture, a common *alma mater*—these things will tend to remove distinctions and jealousies which have existed in the past. Upon such a foundation we may build up a technical education such as the scientific improvements and developments of to-day imperatively demand, while conserving all that portion of the training which the experience of generations demonstrates as essential to the production of the self-reliant, responsible, and resourceful seaman of to-day.

In this connection I may quote from the speech of that ardent reformer and capable public servant, Mr. Arnold Forster, the Financial Secretary to the Admiralty, who, speaking at the Guildhall Banquet on November 11th, said:—

He honestly believed that in no department of the State was a higher and nobler quality of service rendered than in the Navy. If he were asked in what he thought the chief and most excellent distinction of the naval service lay, he would say that it was in the traditions of thoroughness of work, of zeal displayed without the stimulus of immediate reward, or the desire for public approbation; and, above all, in the extraordinary loyalty of naval officers to their own service, and the wholesome feeling of comradeship which made every officer speak well of his brother, and dwell rather on his merits and successes, however small, than upon his faults and failures, however marked. He thought it was impossible to exaggerate the value of those traditions, and of this he was certain, that any change which tended to diminish their force or to discount their value would be disastrous to the Navy and to the country which it served. Changes there must be from time to time, but he believed the Admiralty was fully alive to the truth that no change which failed to take into account the best feelings and traditions of the Navy, and which did not seek to extend their enjoyment to all who served in the fleet, could be a wise one, or beneficial to the service.

One of the most important results, from a naval point of view, of the recent Colonial Conference is that an increase in the number of modern men-of-war maintained in commission will have been promoted by the aid of British subjects in the dominions beyond the seas. There is also a larger and wider appreciation throughout the Empire of the peculiar characteristics of naval warfare, and of the fact that those local considerations, which find their natural place in military organisations, are inapplicable to naval organisation. And, further, we have the establishment of a branch of the Royal Naval Reserve in the Colonies, notably in Newfoundland. In Australia and New Zealand a great step has been made in connection with the matter, for it has been agreed that if possible one of the ships of the Australian squadron in permanent commission shall be manned by Australians and New Zealanders, under officers of the Royal Navy, and that ten cadetships in the Royal Navy shall be given annually in Australia and New Zealand. Perhaps the most important document which is to be found in the papers relating to the Colonial Conference is a memorandum which has been prepared by the Admiralty on sea power and the principles involved in it. This memorandum I recommend to the attention of the readers of these Notes. The following points may be said to contain the keynote of our naval policy in its connection with Imperial defence:—

The importance which attaches to the command of the sea lies in the control which it gives over sea communication. The weaker sea Power is absolutely unable to carry to success any large military expedition over sea. The truth of this is shown by reference to the history of the past. On the other hand, the advantages which accrue to the stronger sea Power, after it has won the command of the sea, are equally illustrated by historical example. The command of the sea is determined by the result of great battles at sea.

To any naval Power the destruction of the fleet of the enemy must always be the great object aimed at. It is immaterial where the great battle is fought, but wherever it may take place, the result will be felt throughout the world, because the victor will afterwards be in a position to spread his force with a view to capturing or destroying any detached forces of the enemy, and generally to gather the proofs of victory, in the shape of outlying positions in his possession, his shipping and commerce, or even to prosecute over-sea campaigns.

Stress is laid on the importance of the great battle for supremacy, because the great development of the navies of France, Germany, the United States, and Russia, indicates the possibility that such battles may have to be fought in the future. It is the battleships chiefly which will have to be concentrated for the decisive battle, and arrangements must be made with this object during peace

Our possible enemies are fully aware of the necessity of concentrating on the decisive points. They will endeavour to prevent this by threatening our detached squadrons and our trade in different quarters, and thus obliging us to make further detachments from the main fleets. All these operations will be of secondary importance, but it will be necessary that we should have sufficient power available to carry on a vigorous offensive against the hostile outlying squadrons, without unduly weakening the force concentrated for the decisive battle, whether in Europe or elsewhere.

The immense importance of the principle of concentration, and the facility with which ships and squadrons can be moved from one part of the world to another, points to the necessity for a single navy, under one control, by which alone concerted action between the several parts can be assured.

In the foregoing remarks the word defence does not appear. It is omitted advisedly, because the primary object of the British Navy is not to defend anything, but to attack the fleets of the enemy, and, by defeating them, to afford protection to British dominions, shipping, and commerce. This is the ultimate aim. The traditional *rôle* of the British Navy is not to act on the defensive, but to prepare to attack the force which threatens—in other words, to assume the offensive. The strength and composition of the British Navy, or of any British squadron, depends, therefore, upon the strength and composition of the hostile forces which it is liable to meet.

It would be most unfortunate if the idea should prevail that the problem is one of local

defence, and that each part of the Empire or each coast town, whatever might be its importance, can be content to have its allotment of ships, for the purpose of the separate protection of an individual spot, the result of which could only be disastrous. Both at home and in the Colonies it is necessary to arouse a sense of personal interest and of personal possession in the Imperial Navy—a feeling that the protection of our interests, our commerce, and our dominions is an affair of ocean strategy, not one of stationing ships here and there to soothe the apprehensions of every coast town that may seem open to attack. As Lord Selborne has said, the sea is all one, and the British fleet must be all one, controlled by one authority with full power, and full responsibility, guided by but one idea—that the task of the Navy in war time must be to seek out the ships of the enemy wherever they are to be found and to destroy them.

GREAT BRITAIN.

Another of the battleships of the programme of 1898-1900 has now made her trials. This is the *Duncan*, which was built by the Thames Shipbuilding Company and was delivered at Chatham to be completed. During her full-power trials, the mean speed on five runs on the measured mile was 19·11 knots. On that occasion the draught of water forward was 26 ft. 2 in. and aft 26 ft. 11 in. The steam pressure in the boilers was 291 lb. per square inch, and the vacuum in the starboard condensers was 25·4 in., and in the port condensers 26·5 in. The starboard revolutions were 120·5, and the port revolutions 121.1 per minute. The starboard engines had an i.h.p. of 9,196, and the port 9,036, a total i.h.p. of 18,232, with a speed by patent log of 18·9 knots. The *Duncan* is now to be prepared for commission at once.

Information has been published in reference to the makers of the engines and boilers of most of the ships for the 1901-03 programmes. Some of this information has already appeared in these Notes, but it may be as well to give it as a whole. Of the five battleships, the *King Edward VII.*, building at Devonport, will have her machinery supplied by Messrs. Harland and Wolff, and her boilers will be four-fifths Babcock and Wilcox and one-fifth cylindrical; the *Commonwealth*, building by the Fairfield Company, will have her engines made by the same firm, and will be supplied with Babcock and Wilcox boilers. The *Dominion* is to be supplied with machinery by her builders, Messrs. Vickers, Sons and Maxim, and will also have Babcock and Wilcox boilers. The *New Zealand*, to be built at Portsmouth, will have her machinery supplied by Messrs. Humphrys, Tennant and Co., and will have four-fifths Niclausse boilers and one-fifth cylindrical; the *Hindustan* will have her machinery supplied by the builders, Messrs. John Brown and Co., and will have four-fifths Babcock and Wilcox and one-fifth cylindrical boilers. Some interesting details about the fittings of these boilers were given in our Monthly Résumé for November. All these five battleships will have a displacement of 16,500 tons, and a speed of 18·5 knots, the engines being of 18,000 i.h.p. The vessels will be armoured throughout, the heavier guns consisting of four 12-in. pieces, carried in pairs in turrets fore and aft. The secondary armament of ten 6-in. guns will be enclosed in a central battery, separated by armoured screens, but not placed in casemates. Each vessel will have, however, four 9·2-in. guns mounted in turrets at the four upper angles of the citadel, two having a forward fire and two a fire aft. These vessels will therefore be able to fire right forward with two 12-in., two 9·2-in. and two 6-in. guns, and the fire astern will be similarly formidable.

In the Naval Notes for last month the manner in which the armoured cruisers of the *Devonshire* class are to be boilered was described. The machinery of these vessels will in three cases be supplied by the builders; but the *Devonshire* will get her machinery from the Thames Ironworks Company, the *Carnarvon* from Messrs. Humphrys, Tennant and Co., and the *Hampshire* from Messrs. Hawthorn, Leslie and Co. In regard to these six vessels it is officially stated that their armour was provisionally ordered on August 18th last, and the orders were confirmed on September 3rd, the manufacture of the armour being commenced, therefore, just eighteen months after it was announced that the vessels would be built.

Of the two armoured cruisers of the 1902-03 programme, one is to be built at Pembroke and the other by contract. Specifications for the

latter have been sent to the shipbuilders. These vessels will have a displacement of 13,000 tons. They are to carry 9·2-guns, and the anticipated speed is 22 knots, obtained with engines of 24,000 i.h.p.

In a previous issue we referred to four vessels of a new class and type, which were included in the 1902-03 programme. When destroyers were first designed, it was not contemplated that they would be frequently used otherwise than as working from a fixed base. Experience, however, has shown that vessels with greater sea-keeping power are required for service with fleets, and the new vessels will therefore have a separate and distinct function, that of acting as scouts. Their armament will enable them to deal with destroyers, or other small craft with which they may come in contact, but they are not intended to fight heavier vessels, the importance of carrying their news being deemed to outweigh the value of a victory. The private shipbuilders of the country were invited to submit designs for these vessels, and, subject to certain modifications, orders have now been placed for four of them. One, to be built by Elswick, will have her machinery supplied by Sir W. G. Armstrong, Whitworth and Co., and will be provided with modified boilers. A second will be built by the Fairfield Company, who will also supply her machinery, the boilers being of the Fairfield small water-tube type. A third will be built and engined by Messrs. Vickers, and supplied with Vickers' Express boilers. The fourth will be constructed by Messrs. Laird Bros., the machinery being supplied by the same firm, and the boilers being of the Laird-Normand type. The coal carried at the normal displacement is 165 tons, but the full supply will run to 380 tons, which, at a speed of from ten to twelve knots, should give them a radius of action of about 3,000 miles. They will be built of sufficient length, and will be provided with forecastles, thus ensuring good sea-keeping capacity. They are designed to maintain the guaranteed full speed of 25 knots under ordinary conditions of weather. The armament comprises six 12-pounder quick-firing guns—two on the forecastles, two aft, and two amidships; eight 3-pounder quick-firing guns—four on each broadside; and two 18-in. above-water torpedo-tubes. Protection will be afforded by a steel deck, varying in thickness from ⅝ in. to 1½ in., worked into the vessel from end to end, and sloped so that the outer edge falls below the normal water-line. The exact dimensions of these vessels and their tonnage appear to be uncertain, but they will probably be about 350 ft. in length and have a displacement of between two and three thousand tons.

FRANCE.

The French Naval Budget for 1903 has been laid before the Chamber. The total amount is the same as that for the previous year, namely, 306,798,738 francs. There is a diminution of expenses for the maintenance of squadrons at sea and for the Admiralty, but there is a large increase in the charges for new construction, particularly for work in private yards. There is also an increase in the sum required for naval works. The reduction in the charges for the fleet at sea follows from a new arrangement by which the squadron is supplied with reduced complements. This plan has already been tried in the Northern Squadron, and it is now being adopted in the Mediterranean, much against the advice of French naval officers.

In reference to the charge brought against M. Pelletan, of delaying the construction of some of the principal ships, such as the *Patrie*, *Justice*, *Liberté*, and *Verité*, the Minister of Marine has explained to the Budget Committee that his reason for countermanding the construction of these battleships was that naval expenditure had already exceeded the estimates by 15,000,000 francs, and that a similar discrepancy might be expected next year. He urged the impossibility of ordering constructions for which the money had not been voted, but assured the Committee that the work on the two battleships at Nantes and Bordeaux would not be suspended. With regard to the *Republique*, the type of boilers with which she is to be supplied has not yet been decided; but as this vessel is not to be finished until 1906 there is plenty of time for making a decision before then. It is not intended to make any change with regard to her armament.

As regards armoured cruisers, the *Ernest Renan*, a sister-ship to the *Jules Michelet*, is

now under construction at St. Nazaire; but it is stated that her plans are to be completely rearranged, with consequent loss of time. This delay in the completion of the programme has also given rise to a protest against the policy of M. Pelletan.

Rear-Admiral Dupont, writing in the *Gaulois*, very harshly criticises the recent creation of a body of administrators of the Inscription Maritime. Thus, he says, is formed a corps of civil functionaries who will be the creatures of the Ministry, and will end by being a burden to the taxpayers. In other quarters it is alleged that a state of chaos reigns in the Rue Royale.

As regards the submarines, M. Pelletan has stated that he is not in favour of reducing their tonnage, although he believes with Admiral Aube that boats of 30 tons would be useful in certain circumstances. He is in favour of increasing the size of these boats where a large radius of action is essential, but orders for larger vessels cannot be given until the most suitable types have been decided upon. There has been much delay in the construction of the thirteen submarines, and the building of others has been greatly retarded. It is alleged that there are at present twenty submarines in course of construction at Cherbourg, Rochefort, and Toulon. These were ordered in April, 1901, and should have been ready for trials at the end of this year, but owing to the delay in ordering the electric accumulators which supply the motors, the craft will not now be ready.

The experiment of launching the *Kleber*, fully equipped with her masts, guns, engines, and boilers in place, is stated to have been most unsatisfactory, and calculated to lead to further expense. It is feared that, owing to the tremendous weight, the sides of the vessel have been badly strained, and the whole construction weakened.

GERMANY.

The delivery trials of the new battleship *Wettin* were satisfactorily accomplished in August. The vessel has a displacement of 11,900 tons, and, with an i.h.p. of 15,000, has developed a speed of 19 knots. The construction was undertaken by Schichau, of Dantzig, and only occupied thirty-four months. In this connection a rather interesting comparison is given in the *Marine-Rundschau* of the time taken to build the ships of the *Kaiser* class, which have a displacement of 700 tons and engines of 21,000 i.h.p. less than the *Wettin*. The *Kaiser Wilhelm II.*, built at the Imperial Yard, Wilhelmshaven, took forty-one months to build; the *Kaiser Wilhelm der Grosse*, at the Germania Yard, Kiel, took thirty-nine months; the *Kaiser Karl der Grosse*, built by Bruhm and Boss, of Hamburg, also took thirty-nine months; and the *Kaiser Barbarrossa*, built by Schichau, took thirty-three months to construct. At the trials of the *Wettin* in October some trouble occurred owing to the giving way of the supports for the heavy guns, and the vessel had to return to port for repairs. It is stated that the *Wittlesbach Zahringen* and the *Wettin* will be commissioned early next year, and that as the remainder of these ships hoist the pennant the ships of the *Brandenburg* class will be withdrawn in order to go through a similar process of modernising to that which the *Worth* is already undergoing at Wilhelmshaven.

The new division of deep-sea torpedo-boats, building by Schichau at Elbing, is so far advanced that the first boat is now ready for commission. These boats will be numbered S114 to S119. Another similar scheme of construction is to be put in hand next year, but the building and cost of these will figure on the programme for 1904.

RUSSIA.

Progress has been made upon several of the smaller cruisers of the Russian Navy. The *Boyarine*, launched at Copenhagen on June 8th, 1901, is to be delivered to the Russian authorities immediately. The *Otchakoff*, building at Sevastopol, was launched on October 4th, in the presence of the Tsar. Her dimensions are as follows: Length over all, 439 ft. 7½ in.; length on the water-line, 433 ft. 5½ in.; beam, 54 ft. 5½ in.; draught, fully loaded, 20 ft. 7¼ in.; displacement, 6,570 tons. The engines are of 19,500 i.h.p., and will be supplied with steam by sixteen Normand boilers. The speed anticipated is 23 knots. The normal bunker capacity is 720 tons, the full capacity 1,100 tons. The thickness of the armoured deck will vary from ¾ in. to 2¾ in., and her casemates will be protected by 3½-in. and her turrets by 5-in. plates.

The armament will consist of twelve 6-in. guns, four in turrets, four in casements, and four with shields; twelve 2·95-in. guns; six 1·85-in. guns; and two submerged torpedo-tubes. She was begun on March 7th, 1901.

The *Alma*, building at the Baltic Yard, St. Petersburg, recently had the ceremony of the *Zakladka* performed on her by the Tsar. This consists in the placing of a silver plate or tablet, and only takes place after a considerable portion of the ship's hull has been armour-plated. The *Alma* was laid down on May 6th last year, and the ceremony of the *Zakladka* took place on September 25th. The dimensions of the vessel will be as follows: Length over all, 363 ft.; length between perpendiculars, 325 ft.; beam, 43½ ft.; draught, 17½ ft.; displacement, 2,385 tons. The engines, of 7,500 h.p., will be supplied with steam by sixteen Belleville boilers, the anticipated speed being 19 knots, and the normal coal capacity 560 tons. The armament will consist of 2·95-in. and 1·85-in. guns.

The *Kniaz Souvaroff* battleship, which was laid down in September, 1901, was launched in the presence of the Tsar on September 25th, at the Baltic Works, St. Petersburg. The length of this vessel over all is 398 ft.; between perpendiculars, 367½ ft.; beam, 76 ft.; draught, 26 ft.; and her displacement is 13,516 tons. The engines, of 15,800 i.h.p., are to be supplied with power from twenty Belleville boilers, and the anticipated speed is 18 knots. Her normal coal capacity is 1,250 tons. On November 1st the Tsar also performed the ceremony of *Zakladka* on the battleship *Slava*, at the Baltic Yard, St. Petersburg. She belongs to the same class as the *Kniaz Souvaroff*, the *Alexander III.*, the *Borodino*, and the *Orel*.

The *France Militaire* states that the official trials of the armoured cruiser *Bayan* took place at Toulon on October 28th. The engines developed 17,400 i.h.p., and the speed attained was 21 knots, the trials being considered satisfactory.

JAPAN.

It has been announced from Yokohama that a new programme of naval construction has been decided upon, to extend over a period of six years. It is said that the scheme will involve an annual expenditure of about £2,000,000, the total expenditure reaching £12,000,000. Four battleships, six armoured cruisers, and several smaller vessels are comprised in the programme, and the whole will have an aggregate displacement of 120,000 tons. It is stated that the four battleships will be built in England, the cruisers in France, Germany and England, and the smaller vessels in Japan. It is also reported that the carrying out of the scheme adopted is to be spread over ten years, from 1904, and will provide only for three battleships, three armoured cruisers, and two smaller vessels.

AUSTRIA-HUNGARY.

The trials of the Austrian battleship *Hapsburg*, which recently took place at Pola, were interesting, inasmuch as the results obtained constitute, it is believed, a speed record for vessels of similar class and displacement. The *Hapsburg* is the first vessel of the class completed by the Austrian Government, her sister ships the *Arpad* and *Babenberg*, being now in course of construction. The following are the leading dimensions of the vessel, machinery, and armament: Displacement, 8,340 tons; length between perpendiculars, 350 ft.; beam, 65 ft.; mean draught, 23 ft. 3 in., area of midships section at above draught, 1,324 square feet. The propelling machinery is of the twin-screw triple-expansion type, with inverted engines, having four cylinders arranged in manner similar to those fitted on board British first-class cruisers: High-pressure cylinders, diameter, 29·9 in.; mean pressure, 43·8 in.; low-pressure (2), 56·3 in., with a uniform stroke of 37·4 in.; total cooling surface of the condensers, 15,000 square feet; estimated revolutions at full power, 135 per minute; propellers, four-blade type, 16 ft. in diameter, having mean pitch of 16 ft. The steam-generating plant consists of sixteen Belleville boilers of the economiser type, similar to those recently fitted to the battleships and cruisers in our Navy, having a total heating surface of 30,300 square feet and grate area of 864 square feet; the working steam pressure at boilers is 300 lbs., and reduced by automatic valve to 250 lbs. at main engines. The total weight of machinery complete is 1,098 tons. The vessel

is protected by means of an armour belt for over 60 per cent. of its length, the spaces beyond being covered by heavy armoured deck; total weight of armour carried, 2,250 tons. The artillery consists of three 24-centimetre Krupp guns 40 calibres in length, twelve 15-centimetre quick-firing guns 40 calibres in length, and twenty-four quick-firing guns of smaller calibre. The coal capacity is 800 tons, which, at a speed of 12 knots, provides for steaming a distance of 3,600 knots. The conditions of trial were that a mean power of at least 11,900 horse-power should be maintained, and the vessel should be propelled at a mean speed of 18½ knots. The speed of the ship was to be taken during the full-power trial, over a carefully-measured course having a total length of 68 knots. The actual results obtained were as follows: Mean pressure at boilers, 285 lbs.; mean pressure at high-pressure receivers, 224 lbs.; mean revolutions, 141·47 per minute; vacuum, 26 in.; indicated-horse-power, 14,942; mean speed for total distance of 68 knots, 19·62 knots.

ARGENTINA.

The armoured cruiser *Rivadavia*, of the *Garibaldi* type, was launched at Messrs. Ansaldo's yard at Sestri Ponente on October 22nd. At the ceremony, Signor Soliano, of the Ansaldo firm, stated that the new cruiser is not a copy of the *Garibaldi* and the *Cristobol Colon*, but a considerable improvement upon them. Her displacement is about 7,500 tons, and her speed 20 knots. This cruiser and another, building at the same yard, were originally named the *General Roca* and *General Mitra*, they are now to be named the *Bernardino Rivadavia* and *Mariano M[illegible]*.

SPAIN.

A committee has been appointed to consider the proposals to build what will practically be a new Spanish fleet. The programme consists of ten battleships, of 13,000 tons; six to ten cruisers, of 3,000 tons, six torpedo-boat destroyers, thirty torpedo-boats, twenty gunboats, and some other vessels. The cost of building these vessels would be from twenty to twenty-four million pounds sterling, and the cost of their up-keep would raise the annual charge for the Navy to between three and four millions. It is stated that the cruisers *Marques de la Ensenada* and *General Valdes* have been condemned as ineffective, and are to be used for torpedo practice.

UNITED STATES.

The battleship *Maine* has at last been accepted by the Navy Board, after a revision of the report of her trials, when it was discovered that she had just attained the desired speed of 18 knots. The Board state that the working of the machinery, both main and auxiliary, was satisfactory.

Bids for the construction of the largest battleship ever projected by the United States Navy have been accepted from the Newport News Company with a bid of $3,990,000. This vessel will be named the *Louisiana*, while her sister ship the *Connecticut*, will be built at a navy yard. These vessels were more fully described in our October issue.

A dispute which arose among the members of the Navy Board about the construction of the armoured cruisers of the *Tennessee* class has been settled by the decision of the Board of Construction to reduce the weight of machinery in these vessels from 2,250 tons to 2,060 tons. The speed is not to be less than 21·5 knots, and the h.p. is to be 23,000. The vessels of this class will therefore be shortly put in hand when the contracts have been decided upon. It is estimated that these vessels will represent, when in commission, an expenditure of $6,000,000.

The annual report of the Chief Constructor of the United States Navy shows that the progress made upon the ships in hand has been far from satisfactory. The battleship *Nebraska*, building at Seattle, and the three armoured cruisers *California*, *Milwaukee*, and *South Dakota*, now building at San Francisco, have been delayed by the non-delivery of steel consequent upon the strikes. The battleships *Missouri* and *Ohio*, and the four monitors, *Arkansas*, *Florida*, *Nevada* and *Wyoming*, have also been delayed, chiefly owing to the inability of the contractors to supply the armour.

The cruiser *Des Moines*, which was launched from the yard of the Fore River Ship and Engine Company, Quincy, Mass., on September 20th of this year, is progressing rapidly.

THE "FUEL" VALUE OF TOWN REFUSE.

BY

ED. C. DE SEGUNDO, A.M.INST.C.E.

The author in this article advances the argument that a Refuse Destructor must be looked upon as a necessary sanitary appliance, and not as a money-earning machine. Nevertheless, the combustion heat of refuse may, within reasonable limits, be profitably applied even for purposes requiring a steady boiler pressure.—EDITOR.

THE disposal of refuse can be looked at in two ways, namely, from a purely hygienic point of view, or from what might be termed a utilitarian point of view. As long ago as the year 1888 the subject of refuse disposal in towns and cities had forced itself sufficiently upon the attention of the authorities to warrant an investigation of the whole matter by the Local Government Board. Colonel Thomas Codrington was instructed to report upon the subject, and in the course of time presented a report which was not only highly interesting and instructive, but also contained some valuable information upon what has recently become a bone of contention amongst certain engineers, namely, the calorific value of dust-bin and other refuse. The average composition of refuse, as set forth in Colonel Codrington's report, should be conclusive evidence to any impartial minded person that the only thing to be done with refuse is to burn both it and its products of combustion in such a way as to render it absolutely innocuous, and no doubt Colonel Codrington's investigations did very much to bring into prominence what is known as a "Refuse Destructor." It is not a very happy title for this apparatus, but in spite of other suggested words the word "Destructor" seems to have stuck to any apparatus—the object of which is to destroy refuse by burning.

BURNING *VERSUS* TIPPING.

The investigations of other engineers have placed beyond any doubt that the crude methods of dealing with the refuse of towns and cities amount in some instances to culpable negligence on the part of the authorities. Mr. Francis Goodrich, in a recent article on this subject, drew attention to what he rightly termed a glaring example of improper refuse disposal in the Isle of Wight, near Osborne. It appears that about three miles from Osborne House, and literally only a few yards from a road, there is a heap of refuse which has been tipped on this spot for years past. In another article on this subject, Mr. Goodrich draws attention to the fact that over eight hundred towns and villages in England and Wales alone, with populations of 2,000 inhabitants and upwards, still tip their refuse, and appear to be absolutely apathetic to the risks incurred thereby. On the outskirts of a large and important town in Ireland is to be found a heap of decomposing refuse in such a

condition that its removal would be not only a matter of considerable difficulty, but would be attended by grave risks both to those who disturbed the matter and also to the inhabitants of the town in question.

It would seem, indeed, unnecessary to amplify instances, although the researches of many careful investigators prove beyond all possible doubt that apathy on the part of the authorities is certainly more the rule than the exception.

THE COMMERCIAL USE OF DESTRUCTORS.

While it is beyond dispute that refuse ought to be burnt, it is only natural that those responsible for its disposal should inquire carefully into the commercial aspect of the matter; and at quite an early stage in the comparatively young history of refuse destructors the builders of destructors sought to utilise the heat of combustion of the refuse for some commercial purpose in order to minimise the costs of destruction.

The commercial possibilities of the supply of electrical energy for lighting and other purposes soon attracted the attention of municipal authorities, and in many cases the supply of electric energy became vested in their hands. As these gentlemen also had to deal with the question of the disposal of refuse, it was no doubt quite a natural conclusion for them to come to, that if refuse in being burnt evolved heat, it might conveniently be used for the purpose of generating electrical energy. Naturally, these ideas were fostered by those interested in the building of refuse destructors, and as a consequence many startling claims were made for the calorific value of town refuse and for its steam raising powers. It would be invidious to mention the names of workers in this field. They have been many and various, and, unfortunately, as no standard conditions were adopted for tests of evaporation of water in boilers fired by refuse, the results obtained as to the amount of water evaporated from and at 212° F. have varied between quite astonishing limits.

The following remarks are not designed to convey the opinion that refuse can never have a utiliseable heat value. There are many instances on record where the heat liberated by the burning of refuse is utilised for a variety of purposes which are more or less commercially profitable, and to that extent reduce the cost of disposal. These purposes are many and various, and no doubt the instances to which I refer will be well known to my readers. But the history of refuse destruction is replete with instances of generalisation from individual cases which has caused erroneous impressions to take possession of the minds of local authorities and others as to the extent to which refuse may be relied upon as a fuel in the usually accepted sense of the word. For instance, a measurement is made of the evaporation of water from a refuse-fired boiler, extending over two hours or twenty-four hours, or whatever it may be, the average steam pressure during this period is worked out, the evaporation is reduced to the equivalent amount from and at 212 F., and the refuse in that particular neighbourhood is thereupon labelled as having an evaporative power of so and so many pounds of water per pound. This is misleading, because the non-technical man is naturally led to assume that if one pound of refuse would evaporate a pound of water, then a ton of refuse should be able to evaporate a ton of water, and if he has 100 tons of refuse to dispose of per day, he concludes that he can rely upon evaporating 100 tons of water, which at 30 lbs. per b.h.p. hour should give him roughly 7,000 h.p. hours of mechanical energy to apply to any commercial purpose. He then goes on to work out that one b.h.p. hour is equal to about ten sixteen-candle-power incandescent lamps burning for an hour, so that his 100 tons of refuse should enable him to supply electrical energy for some 3,000 sixteen-candle-power lamps for twenty-four hours. The above argument can, however, never be correct, the reasons for which will become abundantly evident from a consideration of the average composition of refuse in various districts.

COMPOSITION OF REFUSE.

There can be no doubt that the quality of refuse varies considerably in different parts of England, and, indeed, in different parts of the same town; for instance, in residential or manufacturing districts, ash-bin refuse may contain quite a considerable proportion of half-burnt coal or other combustible. On the other hand, in purely agricultural districts, the refuse would probably be of such a character as to

contain scarcely enough combustible to burn itself, much less to evaporate water in a boiler. Moreover, the quality of the refuse varies more or less in every locality with the season of the year.

As an example of the kind of material one finds in town refuse, the following quotation from Colonel Codrington's report will be of interest :—

"These records are sufficient to indicate the varied composition of refuse, and when considering the possible value of refuse for raising steam for any purpose requiring a steady pressure, it must be borne in mind that this class of refuse is not the only one that has to be dealt with in a large town. For instance, during one year at Leeds the following 'articles' were dealt with, in addition to the usual ash-bin refuse: 11 cows, 3 calves, 17 sheep, 4 goats, 298 pigs, 5 turkeys, 2 carcases of beef, 28 quarters of beef, 9 cwt. of pork, 10 cwt. of pickled tongues, 12 cwt. of herrings, 218 cwt. of shell fish, 1 cwt. of sugar, 285 dogs, 109 cats, 13 foxes, 1 'sea serpent,' 147 mattresses, bed pillows, and bolsters, 7 blankets, 36 pieces of carpet, 7 hearth rugs."

Colonel Codrington gives the following list as the standard of the average London refuse :—

Ashes	52·6
Breeze (cinders)	28·8
Soft core (animal and vegetable refuse	14·2
Hard core (broken pottery, etc.)	2·9
Coal	0·15
Bones	0·25
Rags	0·425
Old iron	0·35
Old metals	0·025
White glass	0·075
Black glass	0·225
	100·000

And the average composition of Manchester refuse is given as follows :—

Ashes and excreta in pails ...	64·5
Dust and cinders	34·55
Fish and bones	0·15
Dogs, cats, hens, rabbits, etc....	0·05
Boots, rags, hats, paper, etc. ...	0·05
Vegetable refuse	0·05
Glass, pottery, bricks, etc. ...	0·6
Old iron and tinware	0·05
	100·00

As an instance of the composition and variation of town refuse at different seasons of the year the following analysis of Torquay refuse, taken from Mr. Henry A. Garrett's able paper on this subject, which was contributed at the summer meeting of the Institution of Mechanical Engineers two years ago, is interesting and instructive :—

Refuse for December and January tests consisted of—

	Per cent.
Paper, cardboard boxes, straw packing material and the like... ...	12·29
Vegetable and garden refuse impregnated with fine ash	52·07
Screenings, cinders, clinker, pieces of small coal and the like ...	6·51
Fine ash and dust	25·42
Pots, pans, crockery, bottles, etc. ...	3·17
Rags, bones, etc.	0·35

In December and January refuse is usually admitted to be of the best quality from a "fuel" point of view. Mr. Garrett sampled about 8 tons of refuse collected in June with the following result :—

	Cwts.	qrs.	lbs.
Fish offal	3	2	21
Meat and poultry offal ...	0	3	17
Waste bread, cake ...	0	1	15
Brickbats, stones... ...	0	2	3
Bits of wood, old boxes...	0	0	23
Old tins, pans, pails ...	3	2	9
Bits of old iron	1	1	0
Pots	1	2	4
Bottles and glass	1	3	18
Straw	1	1	8
Waste paper	3	2	17
Vegetable refuse ...	11	3	9
Garden prunings.	4	1	0
Bones	0	1	5
Rags	0	0	17
Bits of canvas	1	1	7
Old boots and shoes ...	0	0	11
Fine dust	77	0	0
Screenings	45	2	0
Bits of coal	0	2	17
Bits of coke ...	0	0	21

A glance at these lists is sufficient to show that, from the point of view of the fuel, town refuse cannot be considered of very high grade. It is, therefore, somewhat difficult to understand how such results as 2 lbs. of water evaporated

per pound of refuse burnt could be seriously put forward as an average result that might be relied upon. This difficulty is accentuated if one analyses the distribution of the heat of combustion of refuse.

ITS HEAT POTENTIALITY.

A comparison of the results of refuse burnt in many districts shows that, on the average, refuse may be taken to contain at least 30 per cent. of moisture, and that on the average at least 30 per cent. consists of incombustible material; this leaves 40 per cent. of material which is more or less combustible. This 40 per cent. is the sole source whence heat can be drawn for the purposes of evaporating the inherent moisture, for supplying the heat necessary for raising the temperature of the mass to that of the furnace, for the heat escaping in the issuing gases, and for the heat required for evaporating the aforesaid 2 lbs. of water per pound of refuse from and at 212° F. Assuming that the temperature of the products of combustion is 1500° F., that the specific heat is 0·23 thermal unit, that the air supplied and the products of combustion amount to 3·5 lbs. per pound of refuse, and that the moisture in the refuse carries away with it only 966 thermal units per pound, we find the following number of thermal units to be necessary for the combustion of the refuse and the evaporation of 2 lbs of water:—

Heat lost in waste gases, say 1,500 × 0·23 thermal units (specific heat of gases) × 3·5 lbs.	1,207
Heat lost in clinker, raised to, say, 2,000 deg. in furnace from 60 deg.—1940 × 0·2 × 30 per cent.	116
Heat lost in evaporation of moisture, 30 per cent. of 966 thermal units ...	290
Heat absorbed in 2·0 lbs. water from and at 212° F.	1,932
Thermal Units	3.545

To this should be added radiation losses, say, 150 thermal units, making a total of 3,545 + 150 = 3,695 thermal units.

Now, these 3,695 thermal units can only have been produced by 0·4 of the pound of refuse which is combustible, which, therefore, must have had a calorific value of 9,230 thermal units per pound. This is, of course, absurd.

It may be suggested that the evaporation of water above referred to is no longer seriously claimed by reputable makers of destructor furnaces, and this is certainly true; at the same time, within the last few months, Mr. Frank Broadbent, in an excellent article which ran through several numbers of the *Electrical Review*, gave a table of the results claimed by many authorities for the evaporation achieved by their destructors, and the figures therein quoted show variations within fairly wide limits. This paper is a most interesting and instructive one, and, of course, Mr. Broadbent is not responsible for the figures nor for the means by which they were obtained, and it is, moreover, impossible to criticise these results upon anything except general lines, for the reason set forth at the commencement of this article, namely, that up to the present no standard conditions for boilers fired by the combustion of refuse have been agreed upon by the various authorities dealing with this subject.

Mr. Dawson gives the calorific value of the combustible constituents of refuse as follows:—

	[illegible]
Coal	9,344
Coke	8,000
Bones and offal...	5,344
Breeze and cinder	4,000
Rags	3,334
Paper, straw, and the like ...	2,534

From these data Mr. Broadbent compiles a table in which the calorific value of each constituent of average quality London ashbin refuse is calculated. He brings the total to 1,428 thermal units per lb., or about one-tenth that of good coal; but it must not be forgotten that on the average only 40 per cent. of refuse by weight consists of combustible, so that the material which can produce 1,428 thermal units is unavoidedly accompanied by one-and-a-half times its weight of incombustible on the average.

Working on similar lines, Mr. Broadbent makes the calorific value of Manchester refuse 3,100 thermal units per lb., and for Torquay refuse (winter) 1,480 thermal units per lb.

Now, taking 30 per cent. clinker and 30 per cent. moisture as fair average conditions for a basis of comparison, we find that (see above) 1,613 thermal units are accounted for in the waste gases, in heating up the incombustible

and in evaporating the moisture in the refuse. In the case of Torquay (winter refuse), therefore, there is no heat available for evaporating water if Mr. Broadbent's calculations and my assumptions are correct. In the case of Manchester refuse, 3,100 – 1613, or 1487 thermal units, would be available for steam raising, being equivalent to $\frac{1,487}{966} = 1{\cdot}54$ lbs. water from and at 212°F, and in the case of ordinary London ashbin refuse, again, there would not appear to be sufficient heat value to consume the refuse itself.

EXPECTATIONS AND MISCONCEPTIONS.

The evaporative power of refuse must of necessity be a fluctuating quantity and wholly unreliable, and all the improvements in destructors or in refuse fired boilers will not alter matters in this direction in the least. If every effort is directed towards turning the refuse destructor into an auxiliary steam producer for the town's electricity works, then the efficiency of the destructor *quâ* destructor will be impaired, and, conversely, if a destructor is worked with a view to the attainment of the highest degree of efficiency in its legitimate sphere, a boiler fired by the products of combustion of the refuse will be wholly unreliable for the purposes of supplying steam under conditions such as obtain in an electric generating station. If the heat utilised is arranged not to greatly exceed the minimum heat output of the furnace in use at any one time, there will obviously be no difficulty in utilising this portion of the heat of combustion for purposes requiring a constant boiler pressure, proper arrangements being of course made for the utilisation or disposal of the surplus steam, so that the boiler pressure will not be thereby unduly raised, and in these circumstances the utilisation of steam from a refuse fired boiler need not interfere with the functions of the destructor as a sanitary appliance. But it will never be possible for the engineer to rely upon refuse as a fuel for steam raising, in the way that many recent writers would have us believe.

The advocates of refuse as a fuel seem to overlook the important difference between refuse and coal or any other "fuel." Whereas the chief characteristic of a fuel is the constancy of its component parts, the very opposite holds good in the case of refuse; and whereas, therefore practically every pound of coal in a ton may be reckoned on to contribute the same proportion of heat when consumed in the furnace, in the case of refuse as fed into a destructor it would be impossible to rely upon two consecutive pounds to produce even an approximately equal amount of heat.

The conditions under which so-called determinations of the thermal value of refuse as a fuel have been made are really quite hopeless. Refuse is fed into the destructor furnace—I had almost said—by the cartload as against the shovelful in the case of coal, and yet the evaporation of a refuse fired boiler is often worked out to two places of decimals after a trial of a few hours' duration. No wonder people are led to take an exaggerated view of the possibilities of refuse!

If it should be desirable to obtain some approximately correct idea of the average heat value of the refuse collected in some particular town or district—though what useful purpose can thereby be served it is difficult to imagine—careful measurements of the amount of refuse destroyed and of the water evaporated should be taken over at least one year, and then it is quite possible that similar measurements taken during the following year would show a different result. If, in addition to these measurements, the boiler pressure be noted where the whole available heat is used to evaporate water, the variations in pressure would be such as to disabuse the mind of any steam user of any false ideas on the subject.

The proof of the pudding is the eating of it, says an old proverb, and there is no instance on record of steam for electric lighting or power purposes being continuously and satisfactorily drawn from a refuse fired boiler to the extent indicated by the number of pounds of refuse burnt multiplied by the alleged evaporative power per pound of refuse.

To again quote from Mr. Broadbent's excellent paper, we find in Table V. a column giving the useful Board of Trade units generated per ton of refuse. Rejecting results obtained from observations extending over less than one month, and from plants where coal is mixed with the refuse, the average works out to nearly 32 kilowatt hours per ton of refuse burnt. These results are obtained at Accrington, Shipley, and Wrexham.

Taking 40 pounds of steam per kilowatt hour as a not too extravagant estimate, 32 kw. per ton of refuse would correspond to $32 \times 40 =$ 1,280 pounds of water evaporated per ton of refuse, or a little over half a pound of water per pound of refuse. This is accounted for by the nature of the districts in which the results were obtained, and of course cannot be taken as representative of the steam-raising power of every kind of refuse.

The foregoing remarks are not designed to convey the view that the heat value of refuse should be entirely discounted. Heat is always heat, however produced, and it is well known that in many towns the steam from refuse fired boilers is utilised for a variety of purposes which admit of intermittent working. In several instances the steam, when available, is used for generating electrical energy for charging secondary batteries. In other cases other means of equalising the supply of and demand for steam have been attempted, *e.g.*, M. Druitt Halpin's Thermal Storage Scheme. In these or similar ways the heat energy of refuse can be turned to some commercial purpose, and thus effect a reduction in the cost of burning. But upon this subject no rules can be laid down—only an intimate knowledge of the requirements of the districts and of the facilities at hand for the disposal of the article produced can dictate how best to utilise the heat from the refuse destructor.

The paramount *duty* of a refuse destructor is to completely consume the refuse within the least possible time from the moment it is delivered by the cart, and to effect its destruction in such a way that no stewing of the refuse prior to its discharge into the furnace takes place, and that the temperature of the combustion chamber is maintained at a sufficiently high point to thoroughly cremate and render innocuous the products of combustion. Further, the design of the flues and of the chimney should be such that all dust is deposited, and that no solid matter finds its way up the chimney to be discharged at its mouth.

In designing a destructor furnace to effect these three important functions, neither trouble nor money should be spared. A refuse destructor must be looked upon as a necessary sanitary appliance, and not as a money-earning machine.

A STATISTICAL REVIEW OF BRITISH COAL AND IRON PRODUCTION.

A STRIKING fact connected with the production of coal and pig-iron is that, while America has outpaced all her records, she has this year been buying both from us. It is also a striking fact that the output of coal in the United Kingdom has declined, although more persons have been employed in mining. In 1901 the decline was 6,134,355 tons on 1900, and the proportions of the decrease were 3·68 per cent. in England, 0·95 per cent. in Scotland, and 0·21 per cent. in Wales. There were 839,178 persons employed in the mines, as against 814,517 in 1900; but the output was only 357 tons per person employed underground, as compared with 382 tons in 1900.

THE EFFECT OF HIGH WAGES.

This serious decrease in productive industry of 25 tons per man is attributable to shorter hours and fewer working days. When wages are high, miners can, and do, take frequent holidays. In any case, the average annual production of the British miner compares badly with that of the American, which is about 550 tons per man. The difference is a very serious one, and is, we believe, due more to the longer working week and fewer holidays in America than to the use of coal-cutting machinery in the mines there, although that is, no doubt, an important item. As to the smaller number of hours worked in the British pits during 1901, it is but fair to add that this was to some extent the result of taking on again reservists and militia men returning from active service. They were put on the books, but as trade was declining, many of the pits were over supplied with labour, and had to choose between running short days and paying off men.

THE USE OF COAL-CUTTING MACHINERY.

As to the use of machinery, it may be noted here that American records show that ten years ago each man in the bituminous mines turned out 2·56 tons per day, and now produces 2·98 tons. This is called an increase of 118 tons per annum per miner. In the anthracite mines the daily production in the same time has increased from 1·85 tons to 2·4 tons. This is claimed as being due to the application of improved mechanical appliances; but there were doubtless some other influences at work as well. There was, everywhere, considerably less demand for coal in 1901 than in 1900, except in America, where an increase of 20,000,000 tons in the output was readily absorbed. Our exports fell off by 2½ million tons, and the consumption in the British blast furnaces was 2½ million tons less than in the previous year, although the price for the year averaged 1s. 5d. per ton lower.

THE PRODUCTION OF ANTHRACITE COAL.

As a good deal of surprise was caused in September and October last by the receipt of orders from the United States for cargoes of anthracite coal to be shipped from Wales and Scotland, it may be explained that this quality of coal is regularly raised in both countries. The Welsh anthracite more nearly resembles American in character than does the

Scotch, which latter is a hard and smokeless coal, mostly used in the furnaces of steam yachts and the like. There is also a small quantity of anthracite produced in Ireland. The following shows the

OUTPUT OF ANTHRACITE IN THE UNITED KINGDOM.

	Tons.
Wales—	
Brecon ...	303,077
Carmarthen	804,555
Glamorgan	923,044
Pembroke	42,190
Scotland	224,780
Ireland	86,016
Total, 1901	2,505,402
1900	2,523,150

These figures, shown here separately for their special interest, are included in the official returns of the entire output of coal in the country, and the output in 1901 was :—

TOTAL OUTPUT IN 1901.*

	Tons.	Increase or decrease on previous year.
England	153,460,284	—5,865,118
Wales	32,686,832	67,837
Scotland	32,796,800	315,404
Ireland	103,029	21,670
Total, 1901	219,046,945	—6,134,355
1900	225,181,300	+5,086,519

Here, then, we find a decrease of 6,134,355 tons, as compared with a previous increase of 5,086,519, say a practical falling off of about 11 million tons. It must cause some surprise to find Scotland recorded as a larger coal producer than Wales, but in the above table the output of the Monmouthshire pits is credited to England, not to the Principality. The output for Wales per county was :—

WELSH OUTPUT, 1901 (MINES).

County.	Tons.
Brecon	442,394
Carmarthen	1,417,427
Denbigh ...	2,398,776
Flint	677,203
Glamorgan	27,708,841
Pembroke ...	42,190
Total	32,686,031

But if we add the Monmouthshire production, the output of the Welsh coalfields would be over 42 million tons. The following is the—

* These figures include the small quantities produced from open quarries (9,705 tons in 1901 and 11,137 tons in 1900) omitted from subsequent tables.

ENGLISH OUTPUT, 1901 (MINES).

County.	Tons.
Cheshire ...	570,216
Cumberland	2,108,360
Derby ...	14,907,344
Durham	33,954,432
Gloucester...	1,524,981
Lancashire	23,660,503
Leicester ...	2,011,350
Monmouthshire ...	9,508,407
Northumberland	11,272,005
Nottingham	8,098,207
Salop	754,858
Somersetshire	928,530
Staffordshire	13,122,272
Warwick ...	3,099,863
Westmorland	898
Worcester	735,800
Yorkshire	26,072,969
Total	153,451,070

It will be seen that the output of Durham alone exceeds both that of all Wales and all Scotland. The following is the

SCOTCH OUTPUT, 1901.

County.	Tons.
Argyllshire and Dumfries ...	127,939
Ayrshire ...	4,046,278
Clackmannan ...	429,836
Dumbarton	501,130
Edinburgh ...	1,364,399
Fife ...	5,601,501
Haddington ...	467,225
Kinross ...	22,528
Lanark	16,603,230
Linlithgow ...	1,316,570
Peebles ...	900
Renfrew ...	2,346
Stirling ...	2,306,880
Sutherland	5,730
Total ...	32,796,510

More than half the output of Scotland is from one county, Lanarkshire. But the output of Durham and Northumberland is far away ahead of all the coalfields. The number of men employed, the average output per underground worker, and the average price at the pit's mouth are as follows :—

	No. of men employed.	Output per man. Tons.	Average price. s. d.
Durham	113,934	393	8 6
Northumberland ...	41,415	345	9 10
All England	[illegible]	[illegible]	[illegible]
Wales	128,783	[illegible]	[illegible]
Scotland	[illegible]	[illegible]	7 [illegible]
All United Kingdom	792,048	350	9 4½

WHERE THE COAL GOES.

The next thing to consider is what has become of all the coal, and the answer, unfortunately, is that the greater portion of it was wasted, in so far as effective power is concerned. About one-tenth of our output goes into domestic use, but not more than 1 per cent. of that proportion is consumed beneficially. Of what is consumed industrially, probably not more than ten per cent. of the theoretical power is actually obtained. But as to distribution, it has been as follows during the last ten years :—

Year	Output Tons.	Exported Tons.	Consumed at home	Consumption per head. Tons.
1892	181,786,871	39,380,756	142,406,115	3·737
1893	164,325,795	37,488,070	126,837,725	3·300
1894 ...	188,277,525	42,687,430	145,590,095	3·755
1895 .	189,661,362	42,907,302	146,754,060	3·752
1896 .	195,361,260	44,586,811	150,774,449	3·820
1897 .	202,129,931	48,128,464	154,001,467	3·867
1898 .	202,054,516	48,266,699	153,787,817	3·826
1899	220,094,781	55,810,024	164,284,757	4·051
1900 .	225,181,300	58,405,087	166,776,213	4·075
1901 .	219,046,945	57,783,076	161,263,869	3·882

In the exports we have included the quantities supplied to the bunkers of steamers engaged in the foreign trade; as also coke in the proportion of 100 tons of coal for every 60 tons of coke shipped, and patent fuel in the proportion of 90 per cent. of coal in every ton of fuel shipped. The amount of bunker coal supplied to British and foreign steamers in the foreign trade in the ten years has been :—

BUNKER COAL SHIPPED.

Year	Tons.
1892	8,600,120
1893	8,126,372
1894	9,294,461
1895	9,407,786
1896	9,937,305
1897	10,455,758
1898	11,264,264
1899	12,226,861
1900	11,752,316
1901	13,586,833

As regards the decrease in the consumption last year it was explained partly by the long continuance of hot weather, but mainly by the reduced activity in the iron industries. The average price at the pit head and in London has thus varied during the ten years :—

AVERAGE PRICE AT PIT HEAD AND IN LONDON.

Year.	England. s. d.	Wales s. d.	Scotland. s. d.	In London Market. s. d.
1892	7 3	8 10	5 9	17 7
1893	6 10	7 8	5 9	19 0
1894	6 7	7 6	6 0	16 4
1895	5 11	7 2	5 4	14 7
1896	5 10	6 9	5 1	14 5
1897	5 11	6 7	5 3	15 4
1898	6 4	6 10	6 1	16 2
1899	7 7	7 9	7 6	18 2
1900	10 6	12 0	10 10	22 0
1901	9 1	11 11	7 11	19 5

It will be seen that not by any means the whole of the great haul of the "famine" year, 1900, was lost last year.

The distribution of the output by water last year was lower in comparison with 1900 :—

SHIPPED BY WATER.

	1900. Tons.	1901. Tons.
Coastwise—		
Coal	17,023,884	17,895,546
Coke	71,180	66,859
Patent Fuel	1,874	305
	17,096,938	17,962,710
Foreign and Colonial—		
Coal	44,089,197	41,877,081
Coke	985,365	807,671
Patent Fuel	1,023,666	1,081,160
	46,098,228	43,765,912
To the bunkers of steamers in the foreign trade	11,752,316	13,586,833

The largest consumption of coal is in the iron industry; but before we go on to that it will be of interest to show the consumption for locomotive purposes on the various railways. The records only go back to 1897 :—

RAILWAY CONSUMPTION OF COAL.

Year	England and Wales Tons.	Scotland Tons.	Ireland Tons	United Kingdom. Tons.
1897	7,429,659	1,573,082	272,913	9,276,254
1898	7,089,942	1,670,563	311,308	9,071,813
1899	8,004,289	1,763,154	298,698	10,066,141
1900	9,000,118	1,779,608	327,396	11,107,122
1901	8,921,178	1,754,680	347,035	11,022,893

IRON ORE.

Turning to iron ore we find a decrease both in the output and in the imports, sufficiently indicative of a decline in the iron trade. The

chief producing districts are Cleveland and North Yorkshire, Lincolnshire, Northamptonshire, and Leicestershire, Cumberland, and North Lancashire, Scotland and Ireland. The richest ore is the hematite produced by the Cumberland and Lancashire mines, which averages over 50 per cent. of metal per ton of ore; the Cleveland ore averages about 30 per cent.; and the Midland ores average about 33 per cent. The following is a statement of the

OUTPUT OF IRON ORE IN GREAT BRITAIN FOR THE YEAR 1901.

District.	Output. Tons.	Decrease on previous Year. Tons.	Percentage of total.
Scotland	759,373	80,058	6·2
Cumberland & Lanc.	1,550,447	174,344	12·7
Cleveland ...	[illegible]	[illegible]	[illegible]
Stafford	825,905	258,832	6·7
Lincoln	1,494,474	439,424	12·2
Northampton	1,485,084	137,455	12·1
Other counties	[illegible]	250,278	[illegible]
Ireland	80,532	10,109	0·6
Totals	12,275,198	1,753,010	100·0

The decrease in 1901 is equal to 12½ per cent. on the output of 1900. From this quantity of home ore 4,091,908 tons of pig-iron were smelted in 1901, as compared with 4,666,942 tons in 1900. To come down to counties, the following was the

ENGLISH OUTPUT OF IRON ORE.

County.	Tons.
Cumberland	[illegible]
Derby	2,539
Devon	225
Durham	[illegible]
Gloucester	9,769
Lancashire	549,536
Leicester	593,908
Lincoln	1,494,474
Monmouth	10,733
Northampton	1,485,084
Oxford and Rutland	[illegible]
Salop	25,586
Somerset	411
Stafford	825,905
Warwick	7,267
Wiltshire	7,076
Worcester	4,882
Yorkshire (Cleveland, etc.) ...	5,150,656
Total	[illegible]

Wales and Ireland are both too trifling to enumerate, but the following was the—

SCOTCH OUTPUT OF IRON ORE.

County.	Tons.
Ayrshire	[illegible]
Dumbarton	[illegible]
Edinburgh	[illegible]
Fifeshire	[illegible]
Lanarkshire	[illegible]
Linlithgow	[illegible]
Renfrew	[illegible]
Stirling	[illegible]
Total ...	759,373

To make up for the smallness of our deposits of hematite ore we have to import ore for steel-making iron. It remains to be seen how the new process of obtaining steel-making iron from ordinary ore will stimulate the output of ore in Cleveland. But last year even our imports of foreign ore declined, although in 1900 so much effort was exerted to beat up new sources of supply. In the following table we show the quantities received from our several suppliers in 1900 and 1901 :—

IMPORTS OF IRON ORE.

From	1900. Tons.	1901. Tons.
Algeria ...	141,624	180,014
Australia	5,313	6,375
Canada	4	3,124
France ...	48,165	44,930
Greece	304,048	303,835
Holland	9,414	13,670
Italy (Elba) ...	88,532	70,362
Newfoundland	13,234	35,576
New Zealand ...	28	
Portugal	11,738	20,040
Spain ...	5,551,550	4,740,933
Sweden ...	98,055	87,575
Turkey	8,061	7,627
Other countries	17,588	16,827
Total	6,297,903	5,548,888

It is still a case of Spain first and the rest nowhere, even though the readily available supplies of the best Spanish ore are nearing exhaustion; but great things are expected of Sweden in the near future. And we have always Newfoundland and Nova Scotia to resort to for ore for basic iron, for the production of which, on a large scale, our smelters will have to adapt their furnaces.

THE BRITISH OUTPUT.

This brings us to the consideration of our own output of pig-iron in respect of the supplies of coal and ore revealed. Of the quantity of native ore produced, 3,955 tons were exported; and, of the quantity of foreign

ore imported, 8,127 tons were exported. The amount available for home use was reduced by the sum of these quantities, but a further quantity of material was available for the furnaces in the shape of purple ore from the cupreous pyrites imported. From these materials we work up the actual quantity of iron-making material last year as follows :—

IRON ORE AVAILABLE IN UNITED KINGDOM, 1901.

	Tons
Quantity of ore produced at home	12,275,108
Quantity imported ..	5,548,888
Purple ore, from cupreous pyrites	490,108
Total	18,314,274
Deduct—British and foreign ore exported	12,082
Net quantity available for consumption, apart from mill and forge cinders ...	18,302,192

(This quantity compares with 20,882,244 tons in 1900.)

In addition, there were 962,784 tons of cinders, etc., used in some of the furnaces, so that the total quantity of smelting material available was 19,264,276 tons. In smelting this, 16,273,527 tons of coal were consumed, and the product was 7,928,647 tons of pig-iron. In 1900 8,959,691 tons of pig-iron were smelted from 22,100,774 tons of material with 18,742,022 tons of coal. The following shows the distribution of make :—

	Furnaces built	Furnaces at work.	Pig-iron made Tons.
England	443	238 7/12	6,207,868
Wales	43	15 1/12	494,383
Scotland	101	82 11/12	1,136,396
Total, 1901	587	336 1/12	7,928,647
" 1900	604	403 1/12	8,959,691

Now we will analyse the English output by districts and qualities thus :—

OUTPUT OF PIG-IRON IN ENGLAND, 1901.

County.	Hematite.	Ordinary and Basic	Spiegeleisen, Ferro Manganese, etc.	Total.
	Tons.	Tons.	Tons	Tons
Cumberland ...	748,451	2,423	39,215	790,089
Derby and Notts	—	457,510	—	457,510
Durham	436,086	400,766	24,281	961,033
Lancaster	524,806	49,659	68,028	642,493
Leicester and Lincoln ...	—	321,060	—	321,060
Monmouth and Flint	134,280	34,555	36,834	205,669
Northampton ...	36,000	170,101	—	206,101
Salop	—	40,060	—	40,060
North Stafford	—	225,388	—	225,388
South Stafford	—	283,773	—	283,773
Warwick and Worcester	—	57,086	—	57,086
York, North ...	577,923	1,222,924	50,236	1,850,083
" N.W. ...	—	247,045	—	247,045
Total	2,460,446	3,612,828	224,594	6,207,868

The Welsh production was all in Glamorganshire and Denbighshire, and consisted of 468,405 tons of hæmatite and 25,978 tons of ordinary and basic, in all 494,383 tons. The following was the

OUTPUT OF PIG-IRON IN SCOTLAND, 1901.

County	Hemati e.	Ordinary and Basic	Spiegeleisen, etc.	Total
	Tons	Tons.	Tons.	Tons.
Ayrshire	140,303	184,657		324,960
Lanarkshire and Stirling	445,666	358,090	7,680	811,436
Total	585,969	542,747	7,680	1,136,396

Taking the same ten years with which we have dealt above, we now summarise the pig-iron industry thus :—

SUMMARY VIEW OF BRITISH PIG-IRON INDUSTRY.

Year.	Furnaces in blast.	Pig-iron made. Tons.	Ore smelted. Tons	Coal used. Tons.
1892	362	6,709,255	16,344,454	13,860,161
1893	327	6,976,990	16,620,653	13,866,728
1894	325	7,427,342	17,803,998	14,884,866
1895	344	7,703,459	18,629,337	15,224,517
1896	373	8,659,681	21,204,284	17,114,374
1897	380	8,796,465	21,327,013	17,552,436
1898	378	8,609,719	20,958,167	17,166,436
1899	411	9,421,435	22,820,302	19,061,318
1900	403	8,959,691	22,100,774	18,742,022
1901	336	7,928,647	19,264,276	16,273,527

Thus 1899 was the record year everywhere. An idea of how production has been facilitated by enlargement of furnaces, etc., may be gathered from the fact that in 1873 it took 683 furnaces to produce 6,566,451 tons of pig-iron from 16,820,035 tons of ore with 16,718,532 tons of coal. It takes between 2 and 2½ tons of coal to smelt every ton of pig-iron now produced, and the tendency seems to be to increase in fuel consumption as lower grades of ore are used.

To conclude this statistical review we now show the total quantity of pig-iron available for consumption here last year, in addition, of course, to the stocks :—

SUMMARY POSITION OF PIG-IRON, 1901.

	Tons
Produced from British and foreign ore ...	7,928,647
Exported	839,182
Total British make	7,089,465
Plus American and other pig-iron imported ...	195,409
Total pig-iron for British consumption ...	7,284,874

This is less than half the output of pig-iron in the United States last year, nearly all of which was consumed in America.

LOCOMOTIVE ENGINEERING NOTES.

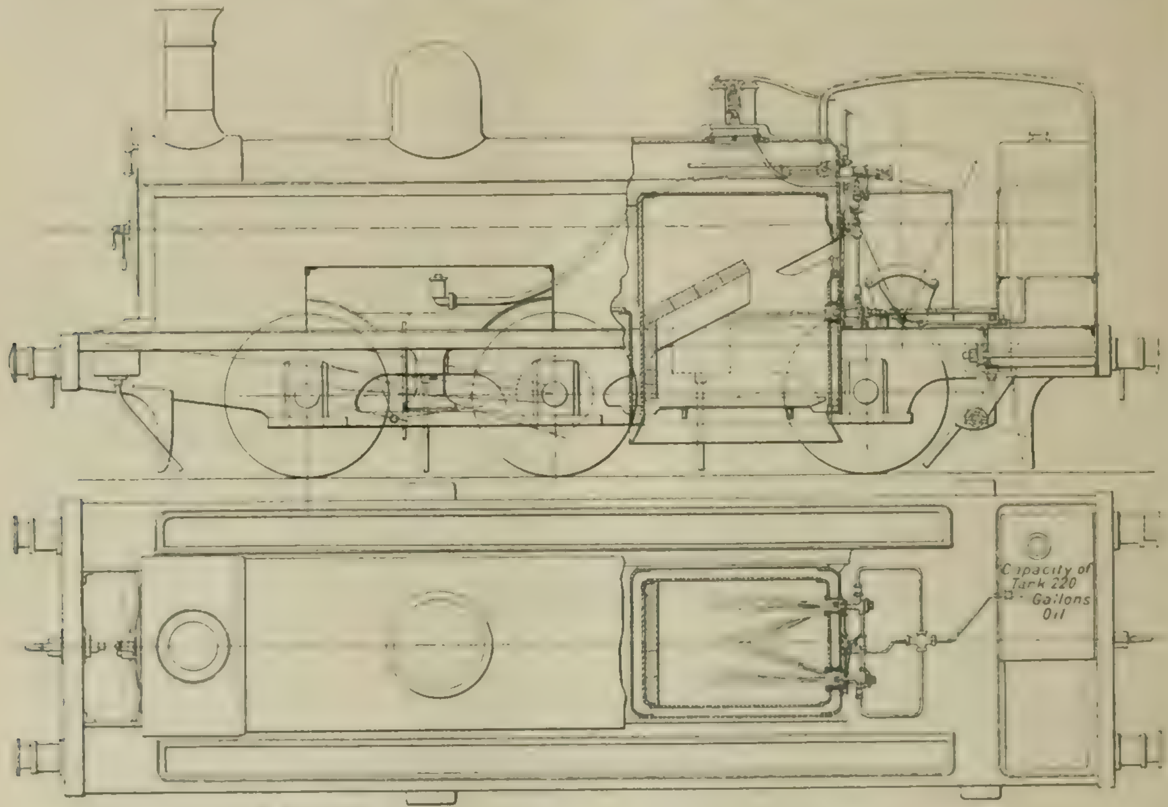
Liquid-fuel for Locomotives.

In a previous number of this Magazine reference was made to the important extension in progress and in contemplation of the use of liquid-fuel in locomotives. There seems to be little doubt that this will prove a prominent factor in the future of railway economics. To what extent its influence will prove operative must of necessity depend largely upon the feasibleness of cheapening the present cost of delivery of the fuel. The entrance of fresh and cheaper sources of supply in the case of the Texas mineral oils has made possible the extended use of this fuel. It must be remembered that when Mr. James Holden, the very able and progressive chief mechanical engineer of the Great Eastern Railway, devised his admirable combination system for that line, his primary object was the destruction of troublesome refuse. The tar resulting from the production both of coal gas and oil gas at the Company's works had to be got rid of. It had been discharged into the nearest stream until the local authorities raised objections to the powerful odour, refusing to be mollified by the prismatic colouration of the surface. The only alternative course appeared to be its consumption in a destructor, but an experiment with a stationary engine proved its capabilities as a fuel used in the generation of steam. But this refuse tar could not profitably be burned in engines fitted up like the Russian and American oil-burning locomotives for the consumption of low-flash-point mineral oils. It had to be used in combination with solid fuel, and this necessity proved the mother of Mr. Holden's ingenious invention.

Liquid-fuel Supplies and Carriage.

But the outcome has been that instead of having engines of special construction which can only be used with their particular brand of liquid-fuel, we have a class that can work equally well with coal, and which, in the almost impossible event of a total stoppage of liquid-fuel supplies, can be run just as well with solid fuel like the Company's other engines: the particular apparatus fitted for the use of liquid-fuel in conjunction with solid would offer no obstacle to the exclusive use of coal. It is this special feature of the Holden method which has brought it into such large use on the railway which was the scene of its original adoption, and which is now opening out such large prospects of extension. For some years past it has been evident that, given the necessary supplies of liquid-fuel at a practicable cost, the system must spread far and wide. Even if liquid-fuel cost somewhat more than coal, there would be large advantages in its employment owing to its possessing the merits of simplicity, cleanliness and saving of wear and tear. It has been tried experimentally on several English railways, and is understood to have been virtually adopted by several of their number. It is no secret that in more than one case it would have been in use long ago had there been any reasonable prospect that the needful fuel could be obtained at a practical cost. But the chief mechanical engineer of one line, who was very anxious to adopt it, on making preliminary inquiries, found that all the available supplies in his neighbourhood had already been secured in advance by the Great Eastern. It has been the cheapening and

extension of the fuel supplies by the Texas oils coming upon the market which has made it possible for other lines to bring the system into use; and present appearances point to considerable further cheapening when the methods of shipment and over-sea conveyance shall be brought more thoroughly up-to-date than at present. So far, the provisions for shipment are of a somewhat primitive character—a rather surprising fact when one remembers that the locality is America; also the steamers used for the trans-oceanic carriage are relatively small and by no means up to modern requirements. Far larger vessels are, however, in course of construction, and it may reasonably be anticipated that a comparatively short period will witness very material saving in the cost of production and conveyance, bringing about proportional cheapening in the cost of the oil on delivery. But even in existing circumstances the system is understood to have been adopted, not only by the North-Eastern, the London, Brighton and South Coast, and the South-Eastern and Chatham Railways of England, but also by the Paris, Lyons and Mediterranean and other Continental lines.



By the courtesy of Mr. W. F. Pettigrew.

LIQUID FUEL LOCOMOTIVE USED ON THE FURNESS RAILWAY.

This Tank Engine, fitted for burning liquid fuel, was built in 1867 by Messrs Sharp, Stewart and Co. for the Furness Railway, and is used chiefly to assist in banking goods and mineral trains between Plumpton and Lindal, a distance of about 3½ miles, with a gradient at some points of 1 in 76; also between Askam and Lindal, a distance of 5½ miles, and gradients in 1 in 63. The cylinders are 18 in. diameter, with a 24-in. piston stroke. The coupled wheels are 4 ft. 7½ in. in diameter. The boiler is 4 ft. 2 in. in diameter, and its barrel is 10 ft. 6 in. long. The length of the firebox casing is 5 ft. 6 in., giving a grate area of 15·6 square feet, the tube-heating surface being 1,016 square feet, and that of the firebox 95 square feet, making a total of 1,111 square feet. The working pressure is 140 lbs. per square inch. The water tanks have a capacity of 1,000 gallons, and the liquid fuel tank of 220 gallons. The total weight of the engine in working order is 44 tons 14 cwt.

Probable effect on Railway Economics.

It is manifest that if these expectations be realised, the effect must be tantamount to something very like a revolution in railway economics. For one thing, as has been already remarked, there will be less wear and tear, owing to the superior cleanliness and freedom from dust, and to the diminished labour placed upon the firemen—also, perhaps, through the simplifying of the duties of both driver and fireman, which may avert a good deal of the distraction of attention from signals, etc., which is almost inseparable from the onerous character of their present duties. But beyond this, it will in a material measure eliminate from railway finance the disturbing element of coal prices. A large quantity of coal would of course still be required, even if Mr. Holden's system came into universal adoption. But the quantity required would steadily decrease, and in view alike of the gradual exhaustion of our British coal supplies and the prevalent tendency to increase in price, this cannot fail to prove a matter of substantial importance.

The Clamour for Electric Traction.

One hears so much nowadays of the possibilities and probabilities of electric traction, that it is curious to reflect how very little is really known on this subject. "Electrification of our railways" is spoken of with a cheerful and free-and-easy confidence as if every difficulty in the way of this change had been completely grappled with and thoroughly overcome. Yet it would be much more accurate to say that electric traction, as applied to railways, is still in its very tender infancy. That it can be and has been applied with much success—and a few mishaps—to urban and suburban railway working, albeit to a strictly limited extent, is of course quite true. That its use in these phases of railway work will rapidly and steadily increase is also virtually certain. But even allowing the widest scope of possibility on the basis at present existing, it must be candidly admitted by all who are thoroughly conversant with the necessities of the case and the obstacles to be overcome, that a very great deal more has still to be achieved before any sane management could prudently recommend the complete electrification of a great railway system. Not many months ago the question was directly raised as to whether the terrible overcrowding and perpetual blockade of one of London's most important suburban railways might not be remedied by the adoption of electricity as the motive power. The matter was most carefully considered by the engineering department, which was inclined to be favourable to the change if proved feasible. But the lowest estimate of the cost involved the expenditure of at least a million and a half sterling, which could by no possibility earn any extra revenue. With this huge financial obstacle on the threshold of conversion, even in the case of the mere suburban section of a leading line, it is manifest that were the field of operations to be one of the vast main line systems, such as that of the Great Western, London and North-Western, or Midland, the financial probability would become one of gigantic dimension; thus, before even the idea could be seriously entertained, the ruling powers of a great railway would need to be conclusively convinced that the system would be not only in all respects feasible and convenient, but also would be a very distinct improvement upon steam locomotion. Otherwise its adoption would be in the highest degree imprudent, if not suicidal. That the working of main lines by electric traction may become practicable in the course of time is probable enough, but as matters now stand, it would certainly be unwise for railway companies to waste valuable time and money in extensive experiments with a new and relatively untried system, instead of devoting their attention rather to the improvement of present methods, especially in the direction of getting as much as possible out of steam traction.

British Neglect of Compounding.

Keeping this manifestly important aim in view, most railways, alike in Britain and on the European and American continents, are making strenuous endeavours to increase the available power of their steam locomotives. But the possibilities under this head are unavoidably restricted by the dimensional limitations which rail-gauge and load-gauge impose upon designers. It is therefore manifestly

desirable to utilise to the utmost extent possible the limited dimensions that are available. This is where the advantage of compounding comes in. It does not enable a larger boiler to be employed, but it does enable the steam supplied by a boiler of given size to be used to far greater advantage, because it is used twice over. When Mr. F. W. Webb tried a four-cylinder single-expansion high-pressure locomotive on the London and North-Western, he found that his standard boiler could not keep four 15 in. cylinders supplied with "live" steam. But a sister engine, identical in all respects, save in being a compound, obtained ample steam from the same boiler for her two 15-in. high-pressure cylinders, and used it over again with marked advantage in her two 20½-in. low-pressure cylinders. Consequently she proved a success and was multiplied sixtyfold, while the other was converted into a compound also, and, as converted, has done excellent work. On every main line in France, compound engines have long been working with complete success, so too in many other countries. Yet British engineers of the present day have hitherto proved strangely shy of adopting the compound plan, with the exception of Mr. Webb, who has built nearly three hundred compound locomotives for the London and North-Western, and very recently Mr. S. W. Johnson, who is trying two on the Midland line.

Sporadic Experimentalisation.

It is not easy to understand this British reluctance to employ a method which has proved so successful elsewhere. One reason perhaps may be found in that prevalent but quite mistaken idea that some discredit attaches to a chief mechanical engineer, who adopts a system invented by someone else, instead of inventing a brand-new one of his own. He may fear that he will seem lacking in originality and initiative if he advocate the adoption of another man's method and perhaps the payment of royalties for its use. It is difficult to explain otherwise the fact that so many British locomotive superintendents have made casual and sporadic experiments with compounding, yet have in so very few cases produced a successful result. For it is manifest that the practicable variations of design cannot be infinite in number. Thus if one thoroughly successful method be devised, and it be deemed *sine quâ non* that new engines to be built must employ a different method, the balance of probability against such variations proving of superior or even of equal effectiveness, must needs be heavy. It may be that repugnance to accept the initiative of a brother locomotive superintendent in the same country is natural enough, as that might be thought to invite disparaging comparison. But there are other systems of compounding beside that of Mr. Webb, which tested by results, have proved distinctly valuable, such as that of M. de Glehn, which for several years past has been doing such remarkable work within thirty miles of the British coast. Every French main line uses engines constructed on this principle. On most of the leading lines in France all new express locomotives are of this type. That it is more costly in construction is indisputable, but it constantly performs, as a matter of every-day course, work which is deemed sufficient to require *two* engines on several leading British railways, and no fewer than 1,500 of these engines are now at work in Europe. Is it not "passing strange" that none have yet been seen in Britain, where the lines are so seriously overcrowded, where the engines are so often overloaded, and where the demand for increased locomotive power and swifter clearance of the lines is so urgent and incessant and increasing?

Automatic Couplings and British Obtuseness.

A most extraordinary report upon automatic couplings, as used on American railways, was recently made to the London and North-Western Railway by one of its officials who had been visiting the United States for the purpose of special inspection and comparison of railway methods. He says: "Persons who argue in favour of automatic couplings in connection with the safety of the employés, appear to have overlooked the fact altogether that the shunters still have to get between the carriages and waggons in order to make connections

between the vacuum pipes and any other fittings that are required throughout the train, and this is a much more difficult job with the automatic couplings than it is with the ordinary screw couplings in use on the British railways. It is perhaps only fair to state that the figures for 1901, which have recently come to hand, show considerable reduction in the number of employés killed and injured in coupling and uncoupling"—these figures of course being those of American railways.

A Curious Perversion.

"A considerable reduction!" Yes, very considerable indeed! For that reduction amounts to 63 per cent. in the number of persons killed and of 80 per cent. in the number of injured, and this tremendous saving of life and limb is, admittedly, mainly due to the adoption of automatic couplings. It is not surprising that the introduction of this most urgently needed improvement should be delayed in Britain when a prominent official of its leading railway regards an avoidance of more than half the fatal accidents as merely a "considerable" reduction in the casualty lists. Nor is this the only strange perversion implied in this peculiar report. Its *suppressio veri* is astounding. For the enormous preponderance of cases to which the comparison would apply is calmly ignored. It is virtually assumed that *all* vehicles on British railways are connected by screw couplings, and the fact is disregarded that the larger number of coupling accidents occur with the goods waggons which have not screw couplings, such vehicles numbering considerably over one million! Another material fact suppressed by the official writer is that in America the vacuum pipes are now made to connect automatically. These cogent facts, which are suppressed or perverted, either unwittingly or of deliberate intent, "knock the bottom out of" his whole argument against automatic couplings. More will yet be heard of this matter.

Speed of Express Trains.

A great deal has been written in the technical journals recently upon the speed of express trains in England and on the Continent, in which it has been sought to show that in the matter of speed the important Continental express trains are ahead of ours. In this connection the following figures relating to the Great Western Railway Company's express run from Exeter to London may be of interest. On Wednesday, the 22nd October, the train due out of Exeter 12·5 p.m. started 6½ minutes late, and drew up at Paddington one minute in advance of time. The following are the times and distances at the more important points on the journey, together with the average speed between those points:—

	Times.	Distances. Miles.	Miles.	Average speed miles per hour.
Exeter	12.10½			
		31¼	31·25	48·7
Taunton	12.40			
		75¾	44·5	58·05
Bristol (Loop) ..	1.35			
		87	11·25	45
Bath	1.50			
		116¾	29·75	[illegible]
Swindon ..	2.28			
		140¾	24	62·61
Didcot	2.51			
		158	7·25	70·17
Reading .. .	3.5[illegible]			
		175½	17·5	66·08
Slough	3.2[illegible]½			
		193	[illegible]7·5	[illegible]
Westbourne Park	3.37½			
Paddington ..	3.39 (at rest at platform)			

The average speed over the whole journey, that is to say, from Exeter to Westbourne Park, was 56·3 miles per hour, but at times the speed very greatly exceeded any of the speeds recorded above. For instance, on the down gradient just before coming to Taunton Station, the speed for about six consecutive minutes was nearly 73 miles per hour. This is an excellen performance, more especially as there were one or two slight checks by signal.

BUSINESS SYSTEM AND ORGANISATION.

BY

D. N. DUNLOP.

IV.—COST-KEEPING.

WE have, in these articles, fully demonstrated the importance of cost-keeping in all factories or works; therefore the system here described, which has been in practical operation at a large engineering works, and has been kindly communicated through the courtesy of Mr. Albert E. Aspinall, cannot fail to prove of value in factory organisation.

In this case the wages department is controlled by the chief cost clerk. The cost department consists of two sections—i.e., the *Productive section*, in which all accounts, stocks, and wages, connected with the manufacture of the goods are dealt with, and the *Upkeep section*, which concerns itself with the cost of keeping up the plant, running machinery, making alterations and additions to buildings, and all other amounts which cannot be charged to any of the jobs being put through the shops as a direct debit, but which are apportioned at percentage rates.

METHOD OF HANDLING ACCOUNTS.

All accounts rendered, after having been checked in the purchasing department, are passed on to the cost clerk's department, where they are analysed, and the various amounts debited to the proper accounts in the impersonal ledger. Here the direct debits are also charged to the various jobs on hand.

STOCKS.

It is of the utmost importance that the stocks of materials in large engineering and other works should be kept in the most perfect manner.

The principal stocks at the works under consideration are: (1) general stores, (2) fuel, (3) pig-iron, (4) building materials, (5) ganister, (6) limestone, (7) tools. The various articles required by the departments are requisitioned from the stores-keeper, by the heads of departments, on special dockets, one for each material; the stores clerk posts up the dockets and keeps an exact account of all stores received or given out. At stated intervals he examines the contents of the bins and pigeon-holes, checking their contents by his ledger. This method saves much trouble at the annual stock-taking, as the ledger is kept posted up week by week, and prevents the disastrous running short of articles, which may cause delay in the execution of an order placed under penalty in the contract.

In addition to the stores-keeper and his assistant-clerk, each department has its stock-keeper, who daily posts up all stores received or returned.

TOOLS.

A stock is kept of all tools purchased, and, in the case of large machine tools, amounts are

written off periodically for depreciation, and charged to the jobs in hand under the head of cost of production. Small tools are handed out as required, and if lost by a workman are usually deducted from his wages in weekly instalments.

COST BOOKS

or job books generally allow job number for every job in a contract, and all items connected with each job bear that number. The use of different coloured inks for the wages posting of each week has been found advantageous.

A practical and experienced cost clerk may be considered an invaluable assistant to the manager, and should be chosen with the greatest care. He has means at his disposal for ascertaining accurately at a given moment all data concerning cost incurred in any department. The cost clerk looks at all matters from the £ s. d. point of view, and is always on the alert to discover any leakage in wages or material in any job passing through the works; he can detect any want of discretion or good judgment in the foreman or others in charge of any specific job. The cost clerk must be a man of more than average intellect, and has to figure out the most intricate problems of the management, which if unsolved would seriously perplex and hamper the manager, who is anxious that his cost of production should show a good margin for profits and compare favourably with past

CRUSHING PLANT COST SHEET.

For Week ending 190

Material Crushed	T.	C.	Q.	Total cost per Ton crushed.
Matte				
Ore				
"				
"				
"				
"				
Total				

Work	Amount.	Totals.	Cost per Ton crushed.
LABOUR—			
Foreman			
Motorman ..			
Transporterman			
Labour in Crushing Plant ...			
Sundry Labour			
Total .			
GENERAL—			
Fitters and Smiths			
Electricians			
Timekeepers, &c.			
Exceptional Charges			
Salaries and Sundries ...			
Total			
SUNDRIES—			
[illegible]			
Castings			
Stores ...			
Casks			
[illegible]			
Total			
PROPORTIONATE CHARGES—			
Electric Power			
Light			
Tram.			
Total			
Grand Total			

records. The cost clerk endeavours to acquire as much technical and practical knowledge as possible of all the manufactured articles produced by his firm. There is, in fact, no limit to his achievements or experience.

Mr. Aspinall has tried, with admirable success, a system of weekly cost sheets in large electrically-driven smelting works, laid out in the following manner :—

On the wharf, which has storage bins and crushing plant adjoining, a transporter was erected for conveying material to the bins from the ships' holds. Automatic railways also ran the length of the bins, each of which was in addition provided with a revolving-table weighing machine, which weighed every load before skidding it into the bins.

Large crushing mills were erected in sheds adjoining, and the ore, crushed to the required size, was returned to the bins and kept as stores to be issued on requisition. The cost sheet of the crushing department shows in the top section "material crushed," the weight of ore crushed, and the total cost per ton for crushing.

From the analysis of wages, the various debits were collected and placed in the column provided, together with items of general expense apportioned for the week. The cost per ton was worked out under the headings of *labour*, *general*, *sundries and proportionate charges*, the total giving the net cost for crushing. (See figure.)

All charges for unloading the various ores were at once charged in the ledger account against *ores*, to be used as value for ores at stock-taking times.

THE CALCINING DEPARTMENT.

This consisted of revolving plough-geared self-discharging calciners, from whence the ore was passed on to the briquetting department, where, after being mixed with certain fluxes, the material was put through the briquetting press, and discharged by means of a belt into trucks, which conveyed it to the weighing-machine. It was then passed to the

SMELTING DEPARTMENT.

Here the waggons of material were raised to charging platforms by hoists, and charged into the furnace cupola with a proper proportion of flux and coke. The cupola was fitted with two lips for slag and for metal, and the slag was run out into slag pots, wheeled away, and tipped. The metal was run off into moulds. After cooling, the slag was broken up and passed along to the Siemens' furnace or zinc plant department.

For obvious reasons, the cost sheet for the smelting department also takes care of the calcining and briquetting. The costs are, of course, based on *raw weights*, as the first weight is considerably reduced after the moisture has been driven off.

Each section is treated in detail, as in figure, which will serve as a guide. Practical illustrations such as these are of more value to managers than any costly conference summoned to ascertain costs.

SIEMENS' FURNACE OR ZINC PLANT DEPARTMENT.

This plant consisted of eight furnaces, designated by the first eight letters of the alphabet. Here the slag was treated for zinc contents, the fumes driven off being collected in the form of dust in chambers adjoining. The slag was tipped into large steam self-tipping ladles, and dumped on to the slag bank ; the material recovered being passed afterwards through the smelting furnace.

In the cost sheet the same manner of treating the debits under different headings is to be noted.

A glance at the summary reveals the object. A works manager would ask his department manager what material had been put through the furnace during the week, what quantities had been recovered, and what were the costs of production. The cost sheet provides the answers in concise form, instead of the usual exasperating approximate figures still tolerated in some works. (See figure.)

All company directors would do well to demand *weekly comprehensive working cost sheets*, which could be handed round for inspection, affording ample scope for conference, and insuring a greater proportion of profits eventually to the shareholders.

ELECTRIC POWER STATION.

Two 400 kilowatts D.C.A.C. Allis Crocker Wheeler sets, switchboard (two distributing and two feeder panels), three batteries, and Babcock boilers with automatic stokers were utilised. The coal was fed by gravity from bins into the hoppers of the stokers.

SMELTING COST SHEET.

CALCINING COSTS.

Stock of Calcined Material

FUEL.

SUNDRIES.

Proportionate Charges.

WAGES.

GENERAL.

BRIQUETTING COSTS.

SUNDRIES.

Proportionate Charges.

WAGES.

GENERAL.

SMELTING COSTS.

FUEL.

Proportionate Charges.

WAGES.

GENERAL.

ELECTRIC POWER and LIGHT PLANT COST SHEET.

For Week ending

FUEL

WATER

SUNDRIES

I H P

E H P

B T U

STATION SWITCHBOARD

E H P

B T U

E H P

B T U

WORKS FEEDER PANELS

E H P

B T U

E H P

B T U

COST OF POWER AND LIGHT

E H P

I H P

B T U

I H P

E H P

B T U

Wages				Remarks
ENGINE ROOM				
Drivers				
Greasers				
Cleaners				
Boys				
Switchboard Attendants				
Total				
BOILER ROOM				
Total				
COAL ELEVATOR				
Total				
GENERAL				
Total				
ARC AND INCANDESCENT LIGHTING MATERIALS				
Total				
WAGES				
Total				

Engineer and Works Manager

190

ZINC PLANT COST SHEET.

A							
B							
C							
D							
E							
F							
G							
H							

				Totals		
FUEL						
			FURNACES			
ADDITIONS TO CHARGES						
REFRACTORY MATERIALS						
			RECOVERY PLANT			
SUNDRIES						
			GENERAL			
PROPORTIONATE CHARGES						
			Cost per ton of Slag Charged			

RECOVERY	STOCK	SUMMARY

FORMS USED IN CHARGING BOOKS.

DEPARTMENT.

No.	Name	Sat. N.	Sun.	Sun. N.	M.	M. N.	Tu	Tu N.	W.	W. N.	Th	Th N.	Fri	Fri N.	Sat.

Week Ending ....

	/	/	/	Total Shifts and Hours.	Rate.	Amount.	Extension.

Fig. 4A.

FUEL STOCK.

Date Received	Colliery	Waggon No.	Thro' Coal. T. C. Q.	Screened Coal. T. C. Q.	Slack. T. C. Q.	Coke. T. C. Q.	Coke Breeze. T. C. Q.	Where unloaded.
	Brought Forward							

FUEL DISPOSALS.

Date	Department Debited	Thro' Coal. T. C. Q.	Screened Coal. T. C. Q.	Slack. T. C. Q.	Coke. T. C. Q.	Coke Breeze. T. C. Q.	Remarks.
	Brought Forward						

Fig. 4B.

The working cost sheet provides complete analysis of the cost of working the power plant. (See illustration.)

The following method is adopted for calculating the extensions and the power and light which are placed on the left hand side of the sheet :—

$$\frac{\text{Total amperes} \times 250 \text{ volts}}{1000} = \text{B.T.U.}$$

÷ by number of hours worked = units per hour.

$$\frac{\text{Total amperes} \times 250 \text{ volts}}{746} = \text{E.H.P.}$$

÷ by number of hours machines have run = average units per hour. The weight of coal in lbs. ÷ by number of hours engines have run = lbs. of fuel consumed per hour. Total weight of coal consumed × B.T.U. or E.H.P. = fuel consumed per unit hour.

There were in addition large fitting shops, smithy and general stores. A well equipped laboratory adjoined the general offices.

TIME-KEEPING.

Without a good system, time-keeping becomes a source of great anxiety and worry to the manager, and he is continually troubled by reports of discontent over the wages roll on the part of the workmen, who must be made to feel that their time is well and accurately looked after. The following system was in use at the works here described, all departments of which were run with three shifts. An average number of 750 men was employed, the check system of round and square checks for alternate weeks being in force.

The day men lifted their check on entering the works in the morning, at breakfast and dinner hours, pushing them through the slot indicated by the time-keeper, who took up a position directly opposite the tally boards and carefully noted that each man only raised one check for himself. The tally boards had the number clearly painted on them, and the lighting was such that the workman could at any time easily discern the number on his check. The foremen were provided with pocket-books, conveniently ruled, which they used on alternate days for noting the nature of the work upon which their workmen were engaged. These books were deposited each evening in the time office to be entered into the charging books (figs. 4a and 4b). The time-keepers, in addition, went round the works at given times during the day checking against the foremen.

The time of the shift men was checked in the same manner, and the department managers' clerk took the men's time independently and checked it with the time-keeper. The total shifts and hours on any job and the overtime were totalled up, and the amounts carried out in the extension column. Simplicity, thoroughness and reliability are claimed for this system, and in case of dispute ready reference is always available.

FUEL STOCK AND DISPOSAL.

The object of the fuel stock and disposal book is to record the receipt and disposal of the whole of the fuel needed for the furnaces, power stations and other purposes. The figures are checked up every week, and the tonnage used is debited to the various departments. There are, in addition, *smithy debits*, *stores debits*, and *timber debits* books all ruled according to requirements.

GENERAL REMARKS.

A smart manager will leave no stone unturned until he has obtained complete returns of the cost of each department. An efficient staff in the costs department is expensive, but the useful work done amply compensates the firm for the salaries paid. No factory should start a cost department unless it can afford a thoroughly efficient staff. An expert cost clerk has to study his work morning, noon, and night. It is well for the manager to be able to turn over to him the foremen who continually come to consult him on matters concerning the jobs on hand; with the help of the chief draughtsman there is little concerning the work of production which he cannot settle. This will prevent many stoppages of work which occur while the foremen are waiting to consult the manager. It is the cost clerk's business to record all such delays and their cause, and to charge the loss under the proper heading. In short, if a manager once secures a good cost clerk, he will find him an excellent investment.

In conclusion, we would say, take care of the costs and the dividends will take care of themselves. The manager is responsible for the output, and, indirectly, for the dividends also.

AMERICAN RÉSUMÉ.

BY OUR NEW YORK CORRESPONDENT.

NEW YORK, 15th November, 1902.

The Iron and Steel Industries and the Coal Strike.

THE iron and steel industries have been very much upset during the past month by the record-breaking anthracite coal strike, and by the almost unprecedented harvest of grain and crops in general. The strike has, of course, severely crippled the pig-iron producers who depend on anthracite coal, and seems to have made itself greatly felt among the larger number of producers who use coke. While the output of pig-iron has been considerably less than that of previous months, there was a demand that could not have been supplied even if there had been no strike. The resulting large importation of pig-iron is well known. Not the least serious portent, however, in connection with this business is the threatened blockade of the railroads, which are now heavily involved in moving grain. It is believed in some quarters that not only will the railroad blockades extend throughout the winter, but that the ordinary maximum production of pig-iron will not be reached till spring. The outlook is that large importations will continue throughout this period.

What has been said regarding pig-iron applies equally well to steel billets. The demand has been much greater than the supply, and a large amount of foreign orders are said to have been placed, particularly with German manufacturers. In this connection an interesting customs decision was rendered in Philadelphia respecting the duty on German billets. It was asserted that the duty should be based on the cost of the products in Germany, and not on the prices made specially for export business. Exception has been made to this ruling, but as yet no authoritative statement has been made public.

With regard to finished iron and steel, an unusual state of affairs presented itself during the latter part of September. While all the pig-iron and steel billet establishments were pressed to the utmost for deliveries, an over-production occurred in the wire, wire-rod, pipe, sheets and tinplate market. Quite a number of the mills have had to close to await a sufficient demand. In structural shapes the demand is very heavy, and there is much business in merchant bar and steel plates. Steel rails are also in very heavy demand.

The general condition of the iron and steel industries, as here briefly outlined, has called attention to the new state of things in the States. Whereas but a short time ago Europe was looking askance at the so-called American invasion, now prices are generally high and the country is altogether occupied in attempting to meet its own requirements. The balance of trade between the United States and Europe has changed so much that the term " invasion " is becoming ridiculous. According to the report of the Bureau of Statistics the excess of exports over imports was $16,000,000 for September, against $35,000,000 for August. It is interesting to contrast the period of low prices in 1898, when American manufacturers sought business abroad, as typified in the famous Atbara bridge contract, with the state of things now existing, as indicated by the recent assertion that one-half

of the pig-iron production for the first six months of 1903 has already been sold at prices probably one-half as high again as those in the corresponding six months of the present year.

A New Water-power Plant.

The formal opening, on October 25th, of the water-power plant on the Michigan side of the St. Mary's River marks the completion of a wonderful engineering undertaking, and brings forcibly to mind the possibilities of foresight and endeavour. In 1894 the water-power rights of the river, which carries the discharge of Lake Superior into Lake Huron, amounting to 3,500,000 to 7,000,000 cubic feet per minute, were purchased for what is now the Consolidated Lake Superior Company. Since that time a varied number of industries have been established by the company, each addition owing its existence to the desirability of meeting the needs of a predecessor, a large industrial town has arisen, and two water-power plants on opposite sides of the river have been developed, yielding together 80,000 h.p. The American plant is of 60,000 h.p. capacity, and comprises 320 thirty-three-inch turbines, working under a head of something less than 20 ft. The water is led to the power-house through a canal starting from a bay 2,900 ft. long, 950 to 220 ft. wide and 22 ft. deep, cut in the solid rock. The canal is 200 ft. wide, but as it approaches the power-house, expands to 1,400 ft. The power-house acts as a dam in which the turbines are located, and is 1,368 ft. long and 100 ft. wide. For its foundation 1,200 piles 50 ft. long were required, and in the construction of power-house and canal 1,250,000 cubic yards of rock and 3,000,000 cubic yards of earth were excavated, 3,500,000 ft. of piling were used and 900,000 cubic yards of masonry and 170,000 cubic yards of concrete were constructed.

A Recent Addition to the United States Navy.

The *Des Moines*, an armoured cruiser for foreign port protection, was launched on September 20th, at the yard of the Fore River Ship and Engine Company, Quincy, Mass. She is 308 ft. 2 in. long, 292 ft. on the load water line, and 44 ft. broad. She has a displacement of 3,200 tons, with a mean draft of 15¾ ft. Her main engines, two in number, are of the four-cylinder triple-expansion type, having 4,700 i.h.p.; and her boilers, six in number, are of the water-tube type, provided with 300 square feet of grate surface and two stacks, 70 ft. high above the grates. Her accredited speed is 16·5 knots. Bunker capacity has been provided for 700 tons of coal. The hull below water and under the sheet-copper covering is of Georgia pine, bolted with bronze bolts to the steel shell. The flat deck is of 5·16 in. steel: the slopes, opposite the engines and boilers, of 2½-in. nickel steel. Her armament will include ten 5-in. 50-caliber rapid-fire guns, eight 6-pounder guns, two 1-pounder guns and four Colt automatic guns, besides one field gun. Smokeless powder is to be used, and the magazine will hold 250 rounds for each of the 5-in. guns and 500 rounds for each of the 6-pounder guns. Her two masts will carry some 6,000 square feet of canvas, and one of them is to have a "wireless" telegraph attachment.

The Standardisation of Fittings in the U.S. Navy.

The standardisation of the fittings of ships built for the U.S. navy by private shipbuilders has apparently made much progress. Referring to this subject in his annual report, Rear-Admiral Francis T. Bowles, chief of the Bureau of Construction and Repair, says that the builders, having on their own initiative organised a conference on the subject, finally submitted plans of fittings which they recommended for adoption as standards. During the year, forty-four such standards were established, including water-tight manholes, water-tight doors, air ports, coal scuttles, deck lights, warping and towing bitts, lift and force pumps, water-tight hatches, pipe flanges, portable ventilators, metallic ladders and boat davits. In addition, general specifications for electrical appliances on board ship have been adopted, together with standard alloys of copper, tin and zinc.

The Use of Oil Fuel in Marine Engines.

The Liquid-Fuel Board, which has been conducting an elaborate series of experiments on the use of oil in steam boilers for the Bureau of Steam Engineering, has presented its report, although it appears that there is still

much more work which it intends to accomplish. It finds that a marine steam generator can be forced to as high a degree with oil as with coal; that no ill effects have been shown on the boiler; that the firemen are disposed to favour oil, and therefore no impediment will be met with in this respect; that the air requisite for combustion should, if possible, be heated before entering the furnace, as such action undoubtedly assists the vapourising of the oil product; that the oil should be heated so that it can be atomised more readily; that when using steam for atomising the oil, higher pressures are more advantageous than lower pressures; and that the consumption of liquid-fuel probably cannot be forced to so great an extent with steam as the atomising agent as when compressed air is used for this purpose. This is probably due to the fact that the compressed air supplies oxygen for the combustible, while in the case of steam, the rarefied vapour displaces air that is needed to complete combustion. Under heavy forced-draft conditions, particularly when steam was used, the board found it impossible to prevent smoke from issuing from the stack. The average percentage of steam required for atomising the oil was about 4½ per cent. of the entire evaporation, this percentage slightly increasing as higher pressures were used, although, as stated, a greater evaporation was obtained under those conditions.

The Protection of Steel by Portland Cement.

Some valuable information has recently appeared in the report of the Insurance Engineering Experiment Station at Boston, on the subject of the protection afforded to steel by Portland cement concrete. A considerable number of tests were begun in December, 1901, by Mr. P. O. Pearson, under the direction of Professor Charles L. Norton, engineer in charge of the station. Both cinders and sand were used in different proportions with different cements, and with a considerable number of different specimens, but in this connection it will be impossible to explain either the character or methods of testing. Suffice it to say that where neat cement was used, the steel was found as bright as when put in; while in the more porous mixtures the steel was spotted with alternate bright and badly rusted areas. In both the solid and the porous cinder concrete, many rust spots were found, except where the concrete had been mixed very wet, in which case the watery cement had coated nearly the whole of the steel and protected it. The conclusions are that concretes, to be effective in preventing rust, must be dense and without voids or cracks; that they should be mixed quite wet when applied to metal; that the corrosion in cinder concrete is mainly due to the iron oxide in the cinders and not to sulphur; that cinder concrete, if free from voids and rammed wet, is about as effective as stone concrete; that the steel should be clean, scraping or pickling it, if necessary, or using the sand blast. Professor Norton believes that the coating of all steel work with cement before applying concrete, tile, or brick is an absolute essential, if the formation of rust and consequent weakening of the steel is to be prevented. The thickness of the cement layer need not be great, but it should be a continuous coating, without cracks.

The Safe Speeds of Flywheels.

The attractive subject of flywheels and their safe speeds has been recently studied by Mr. William H. Boehm, of the Fidelity and Casualty Company, New York. On the basis of the following formula for the speed—that the peripheral velocity of the rim of the wheel in feet per second is obtained by dividing the tensile strength of the material by its weight per cubic inch, extracting the square root of the quotient and then multiplying by 1·6—he obtains the following figures: for cast iron, allowing 10,000 lbs. per square inch as the ultimate strength of large castings, and adopting a factor of safety of 10, a safe speed of 100 ft. per second. This is for wheels in one piece. For cast steel, with an ultimate strength of 60,000 lbs. per square inch, and weighing 0·28 lb. per cubic inch, the safe speed, with a factor of safety of 10, becomes 233 ft.; that is, 2·66 miles per minute. For hard maple, with a tensile strength of 10,500 lbs., weighing 0·0283 lb. per cubic inch, and with a factor of safety of 20, the rim being built up of segments, the safe speed proves to be 154 ft. per minute.

Nitrates from Air. One of the most interesting developments to report in the field of electricity relates to the fixation of the nitrogen in the air. This work, which means the production on a commercial basis of nitric acid or of nitrates by securing the combination of nitrogen and oxygen in the air, has been achieved by Mr. Charles F. Bradley and Mr. D. Ross Lovejoy, president and electrician, respectively, of the Atmospheric Products Company, of Niagara Falls. According to details recently given out, the essential part of the system is a nitrifying chamber, a cast-iron cylinder about 4 ft. in diameter and 5 ft. high, within which 138 electrodes distributed in 23 levels are revolved about a central vertical shaft. There is a corresponding number of stationary electrodes, with which the revolving electrodes set up arcs, in six vertical rows of 23 each. Six air passages at each of the six rows of stationary electrodes, provide for drawing off the air as fast as it is subjected to the influence of the arc. The scheme is an application of the fact that oxygen and nitrogen can be made to combine by means of the electric arc. The direct current was found more satisfactory than alternating currents. Minimum current, with minimum heat expenditure, and maximum arcing surface are obtained by separating the electrodes quickly after the arc has been formed, which occurs with the 8,000 volts used at a distance of $\frac{3}{16}$ in. To resist a rise in current during the early part of the arc, and to assist in prolonging it in the latter dart, an inductance coil is inserted in each circuit. The arc breaks when it reaches a length of 6 in. to 8 in. The speed of the central shaft is 300 revolutions per minute, so that 414,000 arcs are formed per minute, each of which receives 0·005 ampere. The air passes from the nitrifying chamber through the six channels to a galvanised iron tank, where the nitric oxide is given time to take up more oxygen, and it is then conducted into a stand pipe filled with coke. If nitric acid is to be formed, water is delivered into the top of the pipe, trickling over the coke; if nitrates are to be made, a solution of caustic alkali, potassium hydrate for example, is introduced. Air is passed through the apparatus at the rate of 3 to 4 cubic feet per minute, and about 3 per cent. of the nitrogen is oxidised. Experiments are now being carried on to determine the proportion of oxygen to be added to the air that will, as is believed, give a higher percentage. The company intends before long to operate the works on a large scale.

Improved Conduits for Electric Wires. Recent accidents due to the joint use of underground conduits for high and low-tension electric distribution systems have called forth a paper on the subject by Mr. Charles F. Hopewell, which was read before the International Association of Municipal Electricians, at Richmond, Va. Faulty methods of construction, he considers, comprise all kinds of conduits built of conducting material, such as iron pipes or ducts with an iron covering, where joints every 8 ft. place the cable in contact with iron rings metallically connected to such iron covers. A break-down of insulation immediately charges the entire conduit from manhole to manhole. He advocates the use of non-conducting and permanent material, preferably of tile; single ducts, for high-tension wires; the multiple type for low-tension wires. The low-tension ducts should be laid on top of the high-tension ducts, separated therefrom by 6 in. of concrete cement. The entire system should be imbedded in 3 in. of concrete with 1-in. planking on top. One set of manholes should be used for all high-tension wires, these also containing transformers, and a separate set for the low-tension wires.

Electrolytic Refining of Base Lead Bullion. Some details of a system for the electrolytic refining of base lead bullion have recently been made public by Mr. Titus Ulke in the columns of the *Engineering and Mining Journal*. In view of the highly satisfactory results which have been attained, a brief résumé will be interesting. This system, which was invented by Mr. A. G. Betts, has been applied to a plant of ten tons daily capacity at Trail, British Columbia. The depositing room contains 20 tanks, built of wood and lined with tar. The anodes consist of the lead bullion cast into plates about 2 in.

thick: the cathode sheets, which receive the lead deposit, are thin lead plates obtained by electro deposition upon and stripping from special cathodes of sheet steel. The process is based on the easy solubility of lead in an acid solution of lead fluo-silicate, which possess both stability under electrolysis and high conductivity. The electrolyte is obtained by diluting hydrofluoric acid and saturating it with pulverised quartz. The electrodes are separated by a space of $1\frac{1}{2}$ in. to 2 in. The fall in potential is about 0·2 volt; 10 to 25 amperes per square foot are allowed. One ampere deposits 3·88 grams of lead per hour. At 10 amperes per square foot, the cathode area should be about 1,080 square feet per ton of daily output. The total quantity of electrolyte is 175 cubic feet. It is stated that each ton of lead refined requires the burning of 200 lbs. of coal. In the Betts electrolytic process, nearly all the impurities in the base bullion remain as a more or less adherent coating on the anode. This residue consists practically of all the copper, antimony, bismuth, arsenic, silver and gold contained in the bullion, and about 10 per cent. of its weight in lead. Estimating that the electrolyte will have to be purified once a year, the amount to be purified daily figures out less than one cubic foot for each ton of output. The author of the article believes that the development of electrolytic lead refining signalises as great an advance over the fire methods of refining lead as electrolytic copper refining does over the old Welsh method of refining that metal.

American Coal Product.

The coal production of the world, according to the Monthly Summary of Commerce and Finance issued by the Treasury Bureau of Statistics, amounted in 1901 to 866,165,000 short tons. The shares in the production held by the leading countries were as follows: United States, 34 per cent.; United Kingdom, 28 per cent.; Germany, 19·2 per cent. In 1868 the United Kingdom produced over three times as much as either the United States or Germany. The anthracite mining operations of the United States, which have been much before the public on account of the recent strike, are scattered through a narrow region, principally in Pennsylvania, about 90 miles long. The basins are generally of considerable depth, 2,500 to 3,000 ft., with the beds at an angle of 30 deg. with the horizontal. The seams are sometimes 50 ft. or 60 ft. deep, but those of 6 ft. or 7 ft. have proved most satisfactory as mining propositions.

Steel Linings for Mine Shafts.

Lining mine shafts with steel, owing to the growing scarcity of timber, has been the practice of the Oliver Iron Mining Company, in Michigan, for the past two years. The framing is formed of rails, rivetted together by means of angle-irons. Where there is danger of small pieces of rock falling into the shaft, old wire ropes are employed, stretched length-wise of the shaft close enough together to guard against the possible loosening of large rocks. Where a more secure enclosure was indispensable, 2-in. planking has been used. It is understood, however, that corrugated steel is to be used hereafter in such cases, at least every 100 ft., to prevent the spread of fire otherwise favoured by a continuous lagging of wood. No. 16 corrugated steel, which is $\frac{1}{16}$-in. thick, is perhaps the strongest single thickness available, and if galvanised, it should last a long time.

PAGE'S MAGAZINE

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OUR MONTHLY RÉSUMÉ.

LONDON, 20th November, 1902.

Giant Steamers.

ALTHOUGH there is no improvement in the demand for merchant ships, there seems a growing demand for size. The orders for the two new giant Cunarders to be built under the £150,000 subsidy agreement with the British Government have not yet been placed, while these lines are being written, but it is believed that one will be ordered on the Clyde and the other on the Tyne. Belfast is out of the running in this case, but Belfast has booked the first order from the Morgan Combine, who are bound to take all their new ships from Messrs. Harland and Wolff, so long as that firm can supply them. And from Messrs. Harland and Wolff the Atlantic Transport Company, which is part of the Combine, has just ordered three steamers of 12,000 tons each for the traffic between London and New York. These boats will have names with the "Minnie" prefix favoured by this Company. The Atlantic Transport boats will do the work of the Combine between London and Boston, while the old Leyland boats will run between Manchester and Boston. There is no want of activity in shipbuilding at Belfast, and the Clyde yards (or most of them) are still tolerably well employed, though their order books are running out. But in the North of England there is a decided and increasing depression and a gloomy outlook for the winter months.

Shipbuilding Prospects.

It is just a question whether a reduction in costs would bring forward a new series of contracts just now, or whether the freight markets are so low as to discourage all building of vessels of the "tramp" order, which really do the carrying trade of the world. The run of American orders for coal sent up freights from 7s. to 10s., or so, from the North-East of England to United States ports. With the termination of the anthracite strike, the orders from America for coal stopped

and freight came quickly back to 7s. Then the shipment of pig-iron was resumed. Now, if it were not for the American demand, it is probable that pig-iron would be 10s. or more per ton lower than it has been for quite a number of months. If pig-iron were to decrease into the lower "forties," we might see steel ship-plates down to a tempting price, but at £5 10s. per ton, less 2½ per cent., in Middlesbro', and £5 15s. less 5 per cent., in Glasgow, they are not low enough to enable builders to cut fine. It is not likely that iron will come down much for some months to come, and it is probable that shipbuilding will be quiet all next year.

The Brown and Firth Combination. An important development of the past month has been the amalgamation between the shipbuilding and steel manufacturing concern of John Brown and Co., Ltd., of Clydebank and Sheffield, with that of Thomas Firth and Sons, Ltd., steel manufacturers, Sheffield. The alliance is not a fusion of the two companies into one, but an exchange of shares, much on the same principle as the formation of the "community of interests" between Vickers, Sons, and Maxim, Ltd., Barrow and Sheffield, and William Beardmore and Co., Ltd., Glasgow. At all events, John Brown and Co. take seven-eights of the shares of Thomas Firth and Sons, and pay for them with their own shares. As ordnance and gun-mountings are made at the Firth Works, the new combination will be able to turn out a fully-armed and equipped warship from the raw material. It was boasted of the new American Shipbuilding Syndicate that it was the only concern in the world that could do this. As a matter of fact we have now three private establishments that can do it—the Armstrong Company, the Vickers and Beardmore alliance, and the Brown and Firth combination.

A New Departure. A new departure in shipbuilding since our last notes is the steam yacht *Emerald*, which Messrs. Alexander Stephen and Sons, Ltd., Linthouse, Glasgow, have built for Sir Christopher Furness. In this vessel marine engineers hope to determine some of the problems raised by the application of the marine steam turbine to the propulsion of ocean-going vessels. The *Emerald* is not the first yacht to be fitted with the new type of engine, but she is so built as to be able to demonstrate the economy of fuel at low speeds with steam turbines, as compared with reciprocating engines. At present, all the vessels in which turbines are used are swift, and doubts are entertained of the economy of using turbines in vessels of low speed. The *Emerald* is not intended for high speed, and as she is, so far as model is concerned, a vessel which will compare well with others of a similar type, the results of the experiment should be of exceptional interest. The intention is to obtain a rate of about 16 knots with an entire absence of vibration, and an exceptionally low coal consumption. The *Emerald* is 236 ft. in length over all, 28 ft. 8 in. in breadth, and 18 ft. 6 in. in moulded depth. She has been constructed under Lloyd's special survey to class 100 A1, and has a fine cut-water stem, with a beautifully carved figure-head, a long square stern, and a range of teak-panelled deck-houses extending amidships for about 118 ft. A promenade deck from side to side of the vessel is carried the whole length of the deck-houses, and on it are placed the boats, and a large teak deck-house for deck lounge and navigating room. The vessel has three sets of steam turbines, three shafts and five manganese bronze propellers—one propeller on the centre shaft and two each on the side shafts. All these have been supplied and fitted on board by the Parsons Marine Steam Turbine Company, Wallsend-on-Tyne. The hull has been specially strengthened to prevent any vibration in the structure from the great speed at which the shafts will revolve. In the engine-room, besides the three turbines and their condensers, and the duplicate electric-lighting machinery, there are a large number of auxiliary engines of all kinds. The main boiler, which is of very large diameter, is fitted with Howden's forced draught.

Shipbuilding in the United States. There is trouble in the shipbuilding world of America through want of material. The Chief Constructor of the American Navy states that material and skilled workers are not obtainable in sufficient numbers

to make satisfactory progress with the shipbuilding orders already given out, and this applies to armour-plating as well. The battleship *Ohio*, building at San Francisco, is twenty-nine months behind her time. The *Missouri*, at the Newport News works, is reported to be twenty months late, and so with other ships, ten months being about the usual time behind for large ships, while torpedo craft range up to forty months. The delay in beginning the *Virginia*, *Pennsylvania*, and *St. Louis* of last year's programme has been taken advantage of to make improvements in detail, a new system for the distribution of ammunition being introduced. In his report, Admiral Bowles records substantial progress in the standardisation of fittings. In America 44 details of fittings have been standardised, and in certain classes of ships standard systems of ventilation and drainage have been arranged. The construction department of the United States Navy have arranged to regulate education in naval architecture, and to offer opportunities for students gaining practical experience. The Commissioner of Navigation for the United States reports that during September there were "officially numbered" as built in the United States 123 vessels of 43,743 tons, as compared with 119 of 31,469 tons, in the previous month. Of these 114 of 9,319 tons were constructed of wood, and 9 of 34,424 tons of steel; 70, of 12,708 tons, were sailing vessels, and 53, of 31,035 tons, steamers. The bulk of the tonnage—not less than 34,530—was contributed by Atlantic and Gulf ports, the Great Lakes ranking second with 7,325 tons. The biggest vessels in the record are Cramp's Red Star Liner *Finland*, of 12,760 tons gross, and the Hawaiian SS. Company's *Texan*, of 8,633 tons, built at Camden. The most notable ship in the list is the schooner *Thomas W. Lawson*, of 5,218 tons gross, which has been built at Quincy, Mass. The aggregate for the three months is 103,421 tons, as compared with 68,395 tons in the corresponding period of last year.

New United States Battleship.

Special interest attaches to the tenders submitted by United States firms for the building of a 16,000-ton battleship for the American Navy, as the private firms are to be now compared with the Government establishments. The New York Navy Yard is the first American Government establishment now awarded a contract for a new warship. Five private firms tendered for the building of the 16,000-ton battleship. The Newport News Company, which has got the contract, asked £798,000, and promised delivery in 41 months; the New York Company £808,000, and stipulated 40 months; the Fall River Company, of Quincy (Mass.) £817,400, and 42 months; the Cramp Company £822,800, and 42 months; and the Union Iron Works, of San Francisco, £830,000, and 42 months. These prices are all higher than for corresponding work in this country. As to the time required for construction, the new battleships of the King Edward VII. class will be delivered in from 33 to 36 months from the date of the contract. In the case of the new United States contract ship the *Louisiana*, it is intended on the part of the Navy Department to take careful records of actual costs so as to compare them with the cost of building the sister ship, *Connecticut*, in the Government yard. The penalty for late delivery is £60 per day for the first month and £120 per day after the lapse of the month. The speed is to be eighteen knots for four consecutive hours, and the penalty for shortness in speed is £10,000 for the first ¼ knot deficiency and £20,000 for the second ¼ knot, after which it will be at the discretion of the Secretary of the Navy to accept or reject the ship.

The "Scotia."

An interesting vessel has left the Clyde on a remarkable voyage, viz., the *Scotia*, which the Scottish National Antarctic Expedition have despatched to explore the South Polar region. The *Scotia* set sail under the leadership of Mr. Wm. S. Bruce. The ship was formerly a Norwegian whaler named the *Hekla*, but during the past seven or eight months she has been so thoroughly overhauled on the Clyde that she is practically a new vessel. She is now a barque-rigged auxiliary screw-steamer of about 400 tons, measuring 140 ft. by 29 ft., and drawing about 15 ft. of water. With her new engines and boiler she averaged a speed of over

eight knots at her trial trip. In spite of her immense strength the *Scotia*, whose wooden walls amidships are no less than 25 in. thick, is a well-modelled craft, with fine lines to meet the ice, backed by nine feet of solid timber. The leader, the captain, and the scientific staff are accommodated in an after-deckhouse, the officers in a comfortable cabin amidships, whilst the crew are quartered in the forecastle. The scientific work will be carried on in a deckhouse amidships, the after-part of which forms the galley. Here there is good light for those who have to undertake delicate work, such as with the microscope, hydrometer, and other finely graduated instruments. A second laboratory, mainly for zoology, lies almost immediately below the upper one, between decks, and is reached directly from the upper laboratory. Adjacent to this is a compact and completely-fitted dark-room for photography. Between decks there are two great drums, each containing 6,000 fathoms of cable. The cable is led up on deck to a specially constructed 40 horse-power steam winch, thence over the side of the ship by means of a derrick, for the purpose of trawling and trapping in the greatest depths. The roof of the scientific deck-house and its extension in the shape of a bridge form a centre of activity for the scientists, as this is where all the operations connected with sounding and physical investigation of the ocean will be conducted. The *Scotia* is navigated by Captain Thomas Robertson, of Peterhead, who has had twenty years' experience in Arctic seas, and who has also made a voyage to the Antarctic. The scientific staff consists of half-a-dozen picked scientists, four senior, and two junior. The *Scotia* makes first for the Falkland Islands, where she will coal up before plunging into the Polar area.

Electric v. Steam Winding.

Steam-driven winding engines are notoriously and inevitably extravagant in their steam demands. Hence it is that any really efficient and economical substitute would be heartily welcomed, and would give rise to considerable excitement in mining circles. This is, therefore, a reason why just now so many mining men are looking about for the electrical winding engine, and why so much has been mooted of late about electricity applied to winding, and why generally so many inquiries are being made in reference to this matter. For were there not electrical winding plants exhibited at Düsseldorf? And, what is more, plants like those exhibited, or, anyway, like some of them, are actually being installed in some large collieries in Germany. The idea is to generate electricity in a central station where steam may be used with triple-expansion, condensation, and even super-heating, and to utilise the electricity for winding as well as other purposes. The central power station is at once the feature and the pride of many a German colliery, and, in fact, is certain to astonish any visitor from this country by its magnitude and the exuberance of the equipment.

2,800 h.p. for electric winding.

The largest electrically-driven winding engine, and a conspicuous exhibit in the great machinery hall, but destined for shaft Zollern II. of the Gelsenkirchner Mining Company, has a maximum capacity of 2,800 h.p. The electrical portions consist of two direct current motors for 500 volt current, which are mounted on the same shaft as the winding drum or pulley, and a buffer battery of accumulators numbering 216 elements, each containing nine pairs of plates, which not only serves to ensure a good supply of power, but also serves to regulate the speed, inasmuch as the elements are arranged in groups, which can be brought into, or withdrawn from operations as desired. A few elements are also set apart to serve for smaller operations, such as changing tubs, etc.

Speeds Attainable.

By these means the speed can be increased or decreased in stages, such as 6½, 13, 16½, 19½, 26-33 feet per second, which is the maximum speed to be adopted in ordinary practice to begin with; but the presence of the two motors enables a still greater speed to be attained, for, by coupling them up in parallel the ordinary maximum can be doubled, giving increments to 39¼, 52½-65½ ft. per second. Another advantage of having two motors is that operations can go on with one in case the other is deranged, for

even with a diminished output it is better than stopping altogether. Of course, there are indicators and various safety appliances, whilst the manipulation of the switches is effected by the moving backwards and forwards of a lever, as in the usual course of events. The switching arrangements being installed under the engine-room floor. The Koepe system, with a drum $19\frac{1}{2}$ ft. in diameter is adopted.

Work to be Done

The work to be done ultimately is to wind six tubs, each holding $13\frac{3}{4}$ cwt., that is together 4 tons $2\frac{1}{2}$ cwt., from a depth of 1,640 ft. at a maximum speed of $65\frac{1}{2}$ ft. a second in the quickest part of the wind.

Winding with Three-phase Current.

The second large electrically operated winding engine was only shown in a drawing in the Düsseldorf Exhibition, as it was being erected at Colliery Preussen II. of the Harpener Mining Company, and was to be finished about this time. In this instance a three-phase current is used with the motor again mounted on the same shaft as the drum. The current is supplied to the fixed portion of the dynamo at a voltage of 2,000, and is obtained from a central station, in which there are three three-phase generators each of a capacity of 550 kilowatts when running 94 revolutions a minute. They are run in parallel, and also provide current for pumping and other purposes. They are driven by an 800 h.p. twin-coupled horizontal engine.

Speed Regulation.

The regulation of the speed is effected by a liquid resistance. A continuous flow of soda solution is maintained in a vessel in which are suspended the electrodes. The bottom of the vessel can be closed by a valve ; the liquid then rises in the vessel, and as it rises the resistance is diminished and the speed increased, or *vice versâ*. The valve is operated by the chief working lever. The variation of speed depends upon the duty of the circulation pump, and is independent of the engine-man. Koepe is here again the system employed, and the drum or pulley is in this instance also $19\frac{1}{2}$ ft. in diameter, and the work to be done is to wind 100 tons of coal an hour from a depth of 2,2[illegible]7 ft.

The Load.

The factors in the load are four waggon loads of coal, each of $10\frac{3}{4}$ cwts., together just over 2 tons ; tare of each waggon $6\frac{3}{4}$ cwts., together 27 cwts. ; cage and accessories over $3\frac{3}{4}$ tons ; about 2,395 ft. of $1\frac{5}{8}$ inch rope, 4[illegible] tons ; total load about 12 tons. Speed, $52\frac{1}{2}$ ft. a second.

There are Doubts

This installation is really being put in tentatively. The electrical folks have full confidence, but the mining men are not quite so confident ; consequently the latter, when providing the building for the winding machine, built it sufficiently large to accommodate one of those fine majestic steam winding engines that attracted so much attention at Düsseldorf. The effect is very strange, the electrical plant looks such a diminutive apparatus in the big hall intended for its colossal rival.

Friction Pulleys and Electric Winding.

The third striking electrical winding engine produced in Germany has three friction pulleys in one plane, each a little over 8 ft. in diameter, around which a flat rope winds, passing under the outer pulleys and over the middle pulley, which is placed above the other two and is directly driven by two motors mounted on the same shaft ; the lower pulleys are driven indirectly, the tension of the rope pressing them against the driving pulley. Direct current is used at 500 volts, and with 115 revolutions per minute the engine can develop 200 horse-power. The starting and regulation of speed is effected by an independent engine. The engine can wind $13\frac{3}{4}$ cwt. from 1,312 ft.

Modern Steam Winding Engine.

It is interesting to compare with these a steam winding engine of a recent type such as was also shown at the Düsseldorf Exhibition, and an example of which could be seen working at a pit in the Westphalian coal-field. The one exhibited is intended for the second shaft of the same pit of the Harpener Mining Company—that is, Preussen II., where the three-phase electric plant already referred

to is now installed. This winding engine is on the Thomson system, with two spiral drums on separate shafts, which are driven by an inverted vertical compound engine, of which the principal dimensions are as follow: Diameter of high-pressure cylinder, 32·3 in.; low-pressure, 45·2 in.; stroke of piston, 102·3 in. The steam pressure is to be 180 lbs. The drums are each 18 ft. diameter at the smaller end, 33 ft. at the larger end, and 11½ ft. in width. The total weight of the engine is 470 metric tons.

Duty. The engine is to wind from three depths—these are 2,025 ft., 3,281 ft., and 3,937 ft. respectively, and the useful loads to be drawn from each depth are 8 tubs of coal when working from the shallower depth, 6 tubs from the intermediate, and 4 tubs from the maximum depth. Each tub of coal weighs 11 cwt., so the loads will be 88, 66, or 44 cwts., according to circumstances. The maximum speed will be 72 ft. a second, and the mean speed 33 to 40 ft. a second. It was very impressive to see the contrast between these rival engines intended for similar work. But electric winding can only be regarded as barely incepted; what may we not expect?

Electricity in the Salt Mine. The salt mines of Aussee, in Austria, furnish an excellent example of the successful application of electricity in mining. Power is obtained from a head of water with a 430 ft. fall, which works a high-pressure vertical turbine at 1,100 revolutions per minute, this in turn running a direct-current dynamo also at 1,100 revolutions. The power transmitted into the mine is used for haulage, drilling and ventilation. This haulage is effected by a two-axled mining locomotive worked by a (three horse power) direct current dynamo. The locomotive makes eight journeys in a shift of eight hours, travelling each time one mile and drawing three tubs each with 6 cwt. load; so that 144 cwt. of salt are delivered by it during the shift. The division of time is precisely allotted. Of the 480 minutes of the shift, 40 minutes are allowed for going to work and leaving work, and 30 minutes for resting, 90 minutes for cleaning, lubricating, testing breaks, etc., leaving 410 minutes actual working time. The current also works rotary drilling machines, two of 2 h.p. and one of 3 h.p.

Mining Students Strike for More Work. A strange strike is announced from Leoben Mining Academy, in Austria. The students have become so numerous that the accommodation has become inadequate and lectures have been interrupted, and even discontinued, owing to overcrowding. To this the students took exception, and went on strike, demanding adequate accommodation, and a proper number of lectures. They elected representatives to confer with the authorities and the district council, and even the Government head officials have been approached, and the matter will receive attention. But the students have been warned that discipline must be maintained, and that further breach might lead to the closing of the academy for the season. So peace reigns again in this romantic corner of the Austrian Empire.

NOTABLE BRITISH PAPERS OF THE MONTH.

A Monthly Review of the leading papers read before the various Engineering and Technical Institutions of Great Britain.

SIR WILLIAM PREECE ON RAILWAYS AND TELEGRAPHS.

At the first ordinary meeting of the Society of Arts, held on Wednesday, November 19th, the chairman, Sir William H. Preece, K.C.B., F.R.S., gave an interesting address in which he dealt with the causes which result in successful or disastrous financial undertakings, and endeavoured to show that the commercial conduct of industrial processes arising from the practical applications of discoveries, follow distinct laws, which may be said to constitute a "science of business." After discussing the principles which govern the establishment of public companies, Sir William Preece proceeded to survey, from a broad and general point of view, the progress of certain industries in which he has had more or less personal experience, dealing first with the supply of gas and water.

RAILWAYS.

The curves (fig. 1) show that the commercial soundness of the railway interests in the United Kingdom is in anything but a satisfactory condition.

The mileage of railways open is 22,078.

The capital invested is £1,195,564,478.

The revenue is £106,558,815; ratio to capital, 8·9 per cent.

The expenditure is £67,489,739; ratio to revenue, 63·3 per cent.

The profits are £39,069,976; ratio to capital, 3·27 per cent.

There is no apparent allocation of this difference to depreciation, reserve, or redemption of capital. While capital is increasing, and the growth of traffic both in passengers and goods is satisfactory, the rate of growth of revenue is stationary, and the difference between expenditure and revenue is seriously diminishing. The consequence is that dividends are also diminishing. This state of affairs would be very serious if we did not see daylight ahead.

THE ELEMENTS OF FINANCIAL DISTURBANCE.

What are the causes of the present depression? The first cause is unquestionably Parliament, which legislates for the railway world without the least regard to the science of business or the ordinary requirements of commercial prudence. The enforcement of cheap fares and workmen's trains at the expense of the shareholders is pandering to a sentiment, and savours of a bribe to catch votes.

The operation of the Railway and Canal Traffic Acts of 1888 and 1892 forbids our railways being worked on commercial lines so far as goods and mineral traffic are concerned. What is to be said of a law which places an impediment in the way of reducing rates by enacting that they may not be restored, if their reduction be found not to have led to the expected result, without liability to an expensive law suit? Or to the refusal of permission to restore the rate to its old figure without such elaborate proof of change of circumstances as shall satisfy the Railway Commissioners that it is right to do so? Other industries could not live if exposed to such conditions, and their effect is most detrimental to our railways.

The Board of Trade is ceaseless in its

[illegible] of new regulations. The result of the control of this Department has been most beneficial to the safety of the travelling public. The lives saved annually are untold. We have every reason to be proud of the security of our lines. But the finances of our railway companies have been sadly dislocated by this enforced incessant expenditure, and our managers are much exercised to determine what to charge to capital, and what against annual revenue.

LOCAL TAXATION.

The local authorities and municipalities also are insatiable in their unscrupulous assessment for local taxation. The growth of this drain on the resources of the companies is alarming. The taxation of railways has increased 75 per cent. in the last decade, while that of the whole community has increased only 39 per cent.

Trade unionism has generated a serious labour trouble. Shorter hours, greater pay, and enlarged staff are very desirable for the men themselves, but these advantages are not to be acquired if they lead to financial deadlock and to the disregard of the dictates of commercial law. The men cannot obey two masters, nor can the first masters submit to the external [illegible] self-constituted second masters. If this were submitted to, chaos and bankruptcy would be the result.

THE COMPETITION OF ELECTRIC TRAMWAYS.

The railways are now subject to a very serious competition in the introduction of electric tramways in their suburban districts. The American railway companies have recognised this, and they have not only electrified their suburban lines but they have developed a tramway system themselves to act as feeder to their own system, and to enable them to close stations and transfer passenger traffic to street tramways.

Automobiles will also certainly interfere with passenger traffic.

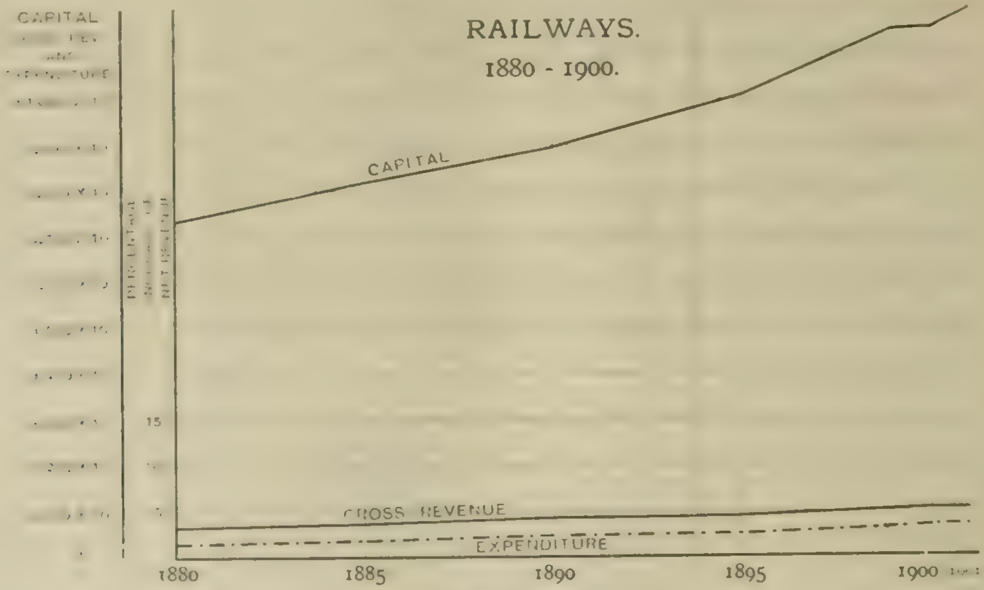


FIG. 1.

RAILWAY COMPETITION.

But the most serious element of financial disturbance is competition among the great railway companies themselves. The demand for increased speed and greater comfort has led to new stations, big hotels, larger locomotives, superior coaches of greater capacity, heavier rails, straightened curves, revised gradients, and reduced distances. Capital has been increased without the productive increase of traffic or earning power, for the expenditure is caused chiefly by the necessity to hold one's own.

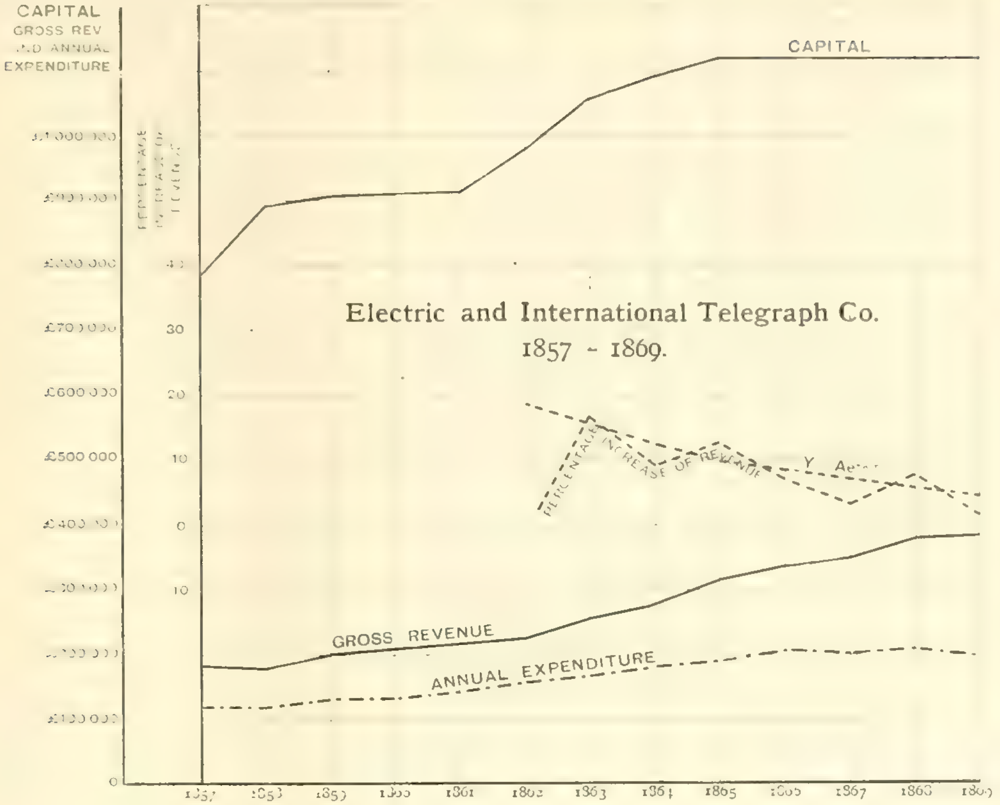


FIG. 2.

THE REMEDY.

Now, what is the remedy? I am no believer in the conception that electricity is to be the panacea for every evil. There is little sign at present of our being able to work main lines economically by electric traction. When, however, a line worked by steam is congested, and you can get no more trains through, as it is on our Metropolitan underground lines, and as it is on many suburban lines, then electric traction comes in to increase the speed of running, to enlarge the carrying capacity of the line, and to reduce the working expenses.

The true remedy is co-operation and combination among the great railway companies themselves, and if the railway companies do not realise this fact, and set to work to put their houses in order, they will find that the last and least desirable, but most effective measure will be enforced upon them by public opinion—the financial control of the railways by the State.

TELEGRAPHS.

Fig. 2 is a diagram of the business of the Electric and International Telegraph Company from the year 1857 to its transference to the Government. It shows steady progress and financial prosperity, following the logarithmic curve. The Government made a good bargain in its purchase; it is the fashion to depreciate this purchase. Indeed it is the inalienable right of virtually half the British race to decry the action of the other half. Facts have no effect on party bias. The £5,715,000 paid by the Government for the telegraphs are now worth £30,000,000, and no one believes it!

Fig. 3 shows the growth of this General Post Office business. It also obeys the logarithmic law. There is no capital. Everything is charged to revenue. The working expenses are apparently very high, but if they were taken as they should be, at a fair commercial figure, say $57\frac{1}{2}$ per cent., the profit would be considerable.

TELEPHONES.

The telephone business of this country defies diagramatic analysis. It has had a curse upon it from its first introduction. It is now in a state of chaotic confusion. It has been the shuttlecock of politicians, and the football of local authorities. The attempt to force it on the municipalities is likely to prove a failure. Tunbridge Wells has lamentably broken down. It is an imperial business, a part and parcel of the business of the Post Office, and the only possible solution of the present deadlock is for the Government to cut the Gordian knot and take over the business in 1911.

DEDUCTIONS.

In all well conducted businesses profit is usually distributed to meet :—

1. *Depreciation*—which is a term applied to the diminution of the value of the plant as a whole, due to time and work acting upon it, and finally causing its complete decay.

2. *Renewals*—which is a term applied to the periodical replacement with new materials of the parts of the plant that wear out most rapidly.

3. *Reserve*—which is a fund invested *outside the business* formed as a species of insurance to be prepared for emergencies, accidents, and fires, and to meet what we call in England *antiquation* of plant, or what they call in the United States *betterment* of plant.

4. *Redemption*—which is the formation of a sinking fund, in the course of time wiping out the capital raised by loan or subscription.

5. *Dividends* and *bonuses*—which are the distribution to shareholders in cash of the surplus of the profit earned.

Sound finance means a proper appreciation of all these points, and a due and proper allocation of a portion of the annual revenue to meet each requirement. Practice is very variable. Different businesses require different treatment.

In electrical industries depreciation and renewals must be continuous, and must be the first charge against revenue. Electric plant must be maintained in absolute perfect order up to the hilt, otherwise it fails to be productive, and rapidly becomes very inefficient. Hence depreciation and renewals are provided for in the ordinary annual maintenance expenditure. Reserve fund is, however, essential in all growing businesses, and the

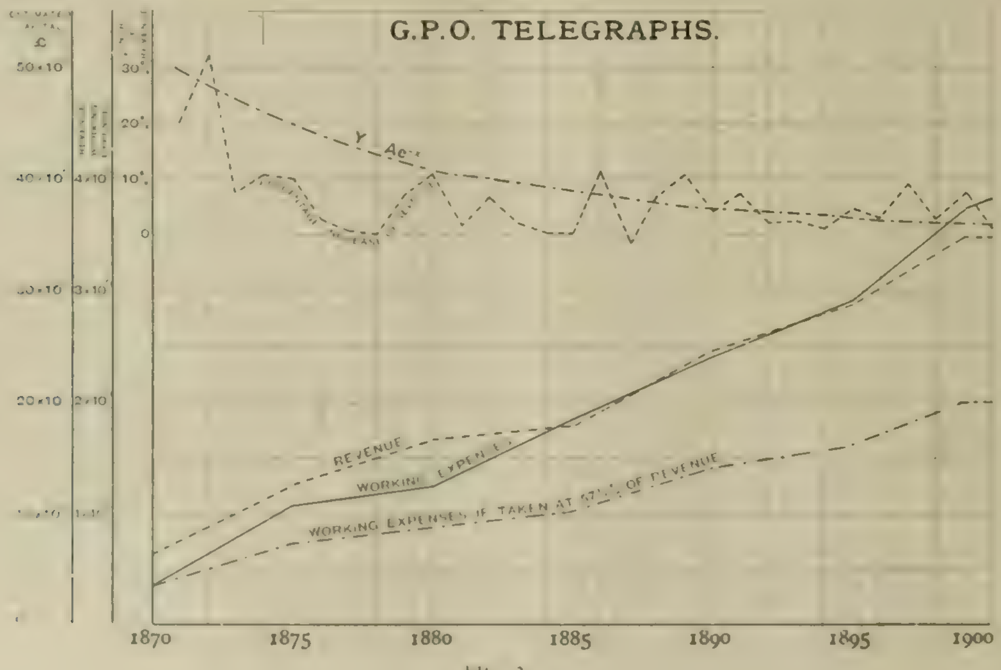


FIG. 3

soundness of the financial control is shown more by the condition of the reserve fund than by any other monetary sign.

MUNICIPAL UNDERTAKINGS AND THE REDEMPTION OF CAPITAL.

Redemption of capital is a compulsory feature of municipal undertakings, erected with capital borrowed under the authority of the Local Government Board. The rate at which the loan is redeemed is determined by the nature of the work undertaken. The present rule is for—land, 60 years; buildings, 30 years; machinery, 15 years; electric mains, 30 years. No dividends or bonuses are allowed in such municipal industries. The profits are devoted to the amelioration of the rates, but in all businesses established by private enterprise under the Limited Liability Act the surplus profits are distributed as dividends and bonuses.

THE FORMATION OF RESERVE FUNDS.

The formation of a good reserve fund is imperative in all undertakings dependent on moving machinery, for invention is so prolific and improvements so rapid that antiquation is soon reached and betterment needed. It is also necessary in the case of private undertakings established under the Tramways or under the Electric Lighting Acts, for in those cases at stated periods the municipality has the power to take possession of the business at its *then* value of the plant, and no allowance is made for goodwill or compulsory purchase. Sound finance seems to show by experience that 2½ per cent. on the capital is about the average amount that should be allowed annually to form a substantial reserve.

There are risky adventures, like submarine cables, where larger amounts should be put aside. The Eastern Telegraph Company is an admirable instance of sound finance. It has been in existence for thirty years. Its invested general reserve fund amounts to £1,164,673 2s. 2d. Its capital is £10,249,170. Its gross revenue is £1,200,000.

THE NECESSITY FOR UP-TO-DATE MACHINERY.

The value of scrapping is not appreciated in England. In America, when a new process is introduced, which effects considerable economy in production, it can be shown by simple calculation that it is wise and commercial to sweep away the old plant and install the new; and this is done. English manufacturers are most tenacious of old machinery. I have seen old Boulton and Watt machinery at work that absorbed annually an excess of coal and oil costing sufficient money to have justified its removal a generation ago. But it is in the increased rate of production that justification for scrapping comes in.

The American does not wait until a machine is worn out before condemning it. As soon as he realises the fact that up-to-date machinery will save him in time and labour enough to justify new plant, away goes the old plant, and the value of the new is soon repaid by greater production. In the majority of cases the "betterment" of machinery is charged against revenue, but it is easy to justify its charge against capital if the value of the increased production exceeds the interest on the sum of the capital invested in the old and in the new plant. However, the judicious manufacturer should be fortified with a reserve fund to provide against antiquation and provide for betterment.

CO-OPERATION AND COMBINATION.

There seems something radically wrong, from a scientific point of view, in some of these gigantic "combines" that have originated in the U.S.A. It is startling to find that each holder of £1,000 in the White Star Line will receive £14,265 for his share from the new Atlantic Shipping Combine. Upon what capital is profit to be distributed which will enable the new holder of £14,265 to be as happy as the late holder of £1,000? Whence are the new profits to come?

It is not even clear where the money is to come from (or the traffic to pay that money) to gain any profit whatever on the millions projected to permeate the soil of London with "tubes."

On the other hand, combinations and co-operative societies, associated with a judicious system of management, must offer considerable economic advantages in encouraging production, maintaining fair prices, securing good markets,

and adjusting a margin between expenditure and revenue which will satisfy buyer and seller.

The key of commercial success is the discovery or construction of a new market, aided by a cheap and reliable mode of distribution. The parcel post is the most efficient means at our disposal to distribute the products of home industries throughout the United Kingdom. Every town and every house thus becomes a new market. We have to educate heads of families in these facts; and this can be done by societies and local industrial exhibitions. Advertising is now a science.

WANTED A BETTER CONSULAR SERVICE.

The crying demand of our countrymen abroad is for representatives who will make the interests of the British merchant their own. What the merchant wants, to secure him an equal chance for business with the rest of the world, is broad-minded and energetic Consuls, and from the facts I have detailed above, it would seem as if there existed sound cause for recommending a great deal of the American method in the constitution and working of a new commercial Consular service, whose motto should be, "English Trade and Commerce, First, Last, and all the Time."

The Germans have an admirable Intelligence Department all over the world. If any electric development is foreshadowed or suggested in any one of our colonies, especially those in which my firm acts as consulting engineer, we at once receive intimation of the fact from Germany and often from America. We never once have received similar information from any British source!

THE EFFECT OF SEGREGATION ON THE STRENGTH OF STEEL RAILS.

At a meeting of the Society of Engineers, held at the Royal United Service Institution, Whitehall, on November 3rd, a paper was read on the above subject by Mr. Thomas Andrews, F.R.S., M.Inst.C.E., F.C.S.

The author observed that in the course of his wide experience as consulting analytical chemist and metallurgical testing engineer to several English railway companies, he had had exceptional opportunities of studying some of the sources of weakness leading to the fracture of steel rails. In order to more fully investigate on a large scale some of the causes of the loss of strength in such rails, he undertook a careful research on the effect of segregation on the strength of steel rails.

Some idea of the magnitude of the experiments will be obtained when it is stated that they have taken nearly seven years to carry out, and that in the course of research complete chemical analyses, physical tests and high power microscopic examinations have been made on a very considerable number of steel rails, the samples experimented upon having been selected from large bulks of rails as supplied to various railway companies.

The general results of the research have shown the importance, in the interests of the public safety, of railway companies having careful chemical, physical, and microscopic tests regularly made on rails, selected from the bulk after delivery to the railway companies, prior to their going into main line service, so that a tendency to a locally segregated chemical composition may be detected and avoided. Much may be done in avoiding a segregated condition in rails by having them made in accordance with the author's chemical and physical specification and tests.

REVIEW OF LEADING CONTINENTAL PAPERS.

A Monthly Review of the leading papers read before the various Engineering Technical Institutions of the Continent.

ELECTRO-MAGNETIC ORE PREPARATION.

"A NOTEWORTHY feature at the Düsseldorf Exhibition were the plans, shown by the Maschinenbau-Anstalt Humboldt, of the electro-magnetic ore preparation plant for the San Fix tin mines, Spain," remarks Engineer Fr. Frölich, of Berlin, in a paper to the *Verein Deutscher Ingenieure*.

The ore from the washery is first dried in a hot coil, the steam given off being drawn away by a fan. By means of a bucket-chain the coil delivers the dried ore into a *Siebtrommel*, or screening drum, with 3-millimetre (barely $\frac{1}{8}$ in.) holes, what does not pass through being crushed between rollers and again brought up to the screen. The ore that passes through is then separated in another screening drum into grains of three sizes, each being further treated independently. The separators are electro-magnets, through whose magnetic field the ore is led by a band travelling on rollers; and these magnets are in each case arranged three together, one behind the other. The separated particles are taken off by cross bands that are brought up under the magnet poles, while what remains, which is less magnetic, is dealt with a second time by more powerful magnets.

The plant, which has been in operation with good results since the beginning of the present year, is so compact that it occupies but little ground space.

LIGHT, HEAT AND POWER FROM ALCOHOL.

THE international competition of motors and other appliances utilising methylated alcohol for industrial purposes, lately held in Paris, formed the subject of two communications to the *Société des Ingénieurs Civils de France*, one by M. G. Coupan on motors, and the other by M. G. Arachequesne on

LIGHTING AND HEATING.

The recent exhibition, he observes, was a decided triumph for appliances using debased spirit for producing heat and light; and the main question as to the possibility of lighting by alcohol is now settled, leaving only the best solutions of that problem to be discussed from the standpoints of safety and economy. The degree of safety against fire and explosion has been greatly increased; and it is not too much to say that at present alcohol appliances entail less danger from explosion than do those burning gas or petroleum spirit, while the alcohol flame is more easily extinguished (by water, generally at hand), than is that of rock-oil.

Whether for lighting or heating, the alcohol must be burnt, which is an easy matter; but the combustion is due to two different principles (1) direct ignition of the liquid spirit, and (2) ignition of the spirit previously vaporised. Appliances depending upon the first of these principles may be again divided into those with (*a*) open vessels, in which the spirit is ignited directly; (*b*) closed vessels in which it is ignited at the end of a cotton wick; and (*c*) vessels in which it is ignited after having been previously absorbed by a porous substance.

Appliances burning alcohol previously vaporised are practically gas-works, in which the retort and pipes are replaced by a small boiler where the spirit is turned into gas; but

what distinguishes one from another is the method of feeding, whether by wick or pressure, and especially the mode of heating. Indeed, it is the mode of heating which permits of sub-dividing these appliances into four classes, according as the spirit is vaporised by (*d*) a permanent pilot-flame; (*e*) a shunt, or subsidiary flame; (*f*) its own flame; or (*g*) regeneration by conduction.

Conformably with theory, heating and lighting appliances that burn carburised alcohol are more economical than those utilising the spirit simply debased, which should be preferred for domestic purposes owing to its high degree of safety, whereas the former is to be recommended for use under pressure, for intensive public lighting, and for automobiles, especially in cold climates.

MOTIVE POWER.

Trials of explosion motors soon showed (observed M. Coupan) that the volume of air incorporated with the combustible substance exerts a marked influence on the motor's economical working, and that the utilisation of the combustible is at its maximum when the proportion of air in the explosive mixture is appreciably greater than that given by calculation according to the chemical reaction. So long, however, as gas, petroleum, shale, etc., were the only combustible substances practically employed for explosion motors, no attempt was made to exactly determine the proportions in which the substances should enter into the explosive mixture for ensuring complete utilisation; but, directly attempts were made to substitute alcohol for raw or rectified petroleum, it became necessary to study the phenomena characterising its combustion, because unexpected difficulties were encountered, such as the fouling, setting fast, and even corrosion of the valves.

It appears from the united investigations of M. Sorel and M. Ringelmann that the combustion of alcohol can never be absolutely complete, however perfect, as regards the proportion of combustible and supporter of combustion, by the composition of the explosive mixture, appreciable traces of acetic acid being always found in the exhaust products. This is, however, but a minor difficulty, as the consequent loss of alcohol is very slight; and this acid does not appear to corrode the parts of the motor, at any rate while working, while lubricating the cylinder after each stoppage is sufficient to prevent the corrosion due to prolonged contact between the metal parts and the condensed products containing acetic acid.

Analyses of the exhaust gases have shown that, without the proper proportion of air, part of the hydrogen, and especially of the carbon, contained in carburised or uncarburised alcohol is entirely unutilised, the loss being specially high in light fast-running engines. In heavy motors the combustion was, in most cases, found to be practically perfect when the proportion of air in the explosive mixture was 1·7 times that theoretically necessary; but above and below this proportion the combustion was imperfect, the degree of utilisation becoming more and more defective as the theoretical proportion was approached. Accordingly, whatever be the mode of regulating the motor, the carburiser should be capable of sending into the cylinder a quantity of alcohol corresponding with the best degree of carburisation, determined in accordance with the cylinder's capacity, account being also taken of the excess of air normally required for the combustion.

The carburiser preferred by the author is one which automatically injects the requisite quantity of alcohol, *in a liquid state*, into a chamber where the volatilisation and mingling with air are effected; and the organ for injection, or, more correctly, mechanical distribution, should be susceptible of regulation, so as to permit of determining empirically the exact quantity of alcohol necesssary for each explosion, while leaving every latitude for use in the motor of various kinds of combustible substances. Provided well-designed carburisers and vaporisers be employed, M. Coupan concludes that alcohol may be regarded as a good agent for producing mechanical energy.

DETERMINATION OF A COAL'S HEATING POWER.

CALORIMETRIC determinations by the Mahler shell have often shown great divergence between actual calorific powers and those found by calculation with the aid of formulæ proposed up to the present time, all of which have been successively

abandoned by M. Goutal whose note on the subject was brought before the *Paris Academy of Science* by M. Adolphe Carnot) on account of their inaccuracy or their being based on delicate and complicated determinations. Inasmuch, however, as the ascertaining of a coal's calorific value by simple calculation appeared to possess a certain industrial interest, the author endeavoured to establish a relation between this calorific value and the results afforded by actual testing—*i.e.*, by calcination, incineration and dessication—for determining the fixed carbon, the volatile matter and the humidity.

After having experimented with 600 samples of coal from various sources, M. Goutal became convinced that the results may be expressed with near approximation by the formula—

$$P = 82\,C + aV,$$

in which P is the calorific value sought,* C the proportion in hundredth parts of fixed carbon, V that of the volatile matter, and *a* a variable multiplier, function of the volatile matter content, V^1, free from ash and water, while

$$V^1 = 100 \frac{V}{C + V}$$

For experimentally determining the value of *a* for various fuels, the author constructed a graphic diagram from the results of his numerous tests, taking the volatile matter contents, V^1, for the abscissæ, and the corresponding values of *a*, deduced from the calorimetric combustions, for the ordinates, this co-efficient assuming, for volatile matter contents of 5, 10, 15, 20, 25, 30, 35, and 40, the respective values of 145, 130, 117, 109, 103, 98, 94, 85, and 80 calories.* For the anthracites *a* is represented by a constant equal to 100 calories, the formula becoming

$$P = 82\,C + 100\,V.$$

In thus calculating the calorific power of a coal, the error rarely exceeds 1 per cent. of the real value; but, as an exception, it is greater than 2 per cent. in the case of some anthracites and some lignitous coals, the value of which can only be ascertained by the calorimeter.

The mean calorific power of pure anthracite is 8,250 calories per kilogramme (14,850 B.T.U. per lb.); that of the anthracitous coals, for which V^1 varies from 5 to 10 per cent., is 8,550 calories per kilogramme (15,390 B.T.U. per lb.); and it attains a maximum, 8,700 calories per kilogramme (15,660 B.T.U. per lb.), in the case of coals for which V^1 is comprised between 10 and 30 per cent.

It follows that the calorific value of coals increases in inverse ratio to that of their volatile matters up to the limit content of 30, after which the calorific value of natural fuels and that of their volatile matters decrease together.

ALUMINOTHERMY.

THIS term is given by Dr. Hans Goldschmidt, of Essen-an-der-Ruhr, to a process applicable to the reduction of metals and heating of metal parts, which is founded on exothermic reaction, progressive and practically spontaneous; and the name was chosen because aluminium has been found to be the metal of moderate cost which, owing to its affinity for oxygen or the high degree of heat given out during its combustion, best serves in most cases as the reducing agent in practical applications of the process.* According to Herr Strauss' investigations the combustion heat of aluminium is 7,140 calories per kilogramme (12,852 B.T.U. per lb.), coming immediately after hydrogen, 34,200 calories (61,560 B.T.U.), and carbon, 8,317 calories (14,970 B.T.U.), being greater than that of the other metals or metalloids. Aluminium may, however, and must even in some cases, be replaced by another metal, so that the field covered by aluminothermy is more extensive than that implied by the term.

PRINCIPLE OF THE PROCESS.

If with a pulverulent metallic compound—oxide, sulphate, etc.—be intimately mixed a metal in the state of powder whose affinity for oxygen, sulphur, etc., is greater than that of the combined metal, and if the mixture be heated, so soon as the mass attains a certain temperature depending on the nature of the substances,

* The author of this paper, M. E. Goutal, head of the chemical laboratory at the Paris School of Mines, has kindly explained that, although the calorific power of coals is generally given in calories per kilogramme, [illegible] the values of *a* in question. The latter correspond with the results of analyses expressed in hundredth parts; in the present case 1,000 ÷ [illegible]. To render these values comparable with the usual measurements they must therefore be multiplied by 100, giving 14,500, 13,000, 11,700, 10,900, 10,300, 9,800, 9,400, 8,500, and 8,000 calories per kilogramme. For obtaining the equivalent British thermal units it is sufficient to multiply these figures by 1.8.

a reaction with disengagement of heat will take place; the oxygenated or sulphated substance will be decomposed, and the metal that was in combination will be set free, while the oxygen or sulphur will combine with the free metal.

This would appear to be a metallurgical process suitable for extracting metals from their ores without coal; but the reaction is so violent as to throw forward to waste part of the substances, while rapidly destroying the receiver containing the mixture. Dr. Goldschmidt has, however, found that this difficulty ceases if, instead of heating the whole mass, the reaction be merely set going by raising a point in the mass to the desired temperature. With a suitable mixture the heat given out by the local reaction thus produced is sufficient to raise neighbouring parts to the reaction temperature, so that the action of the reducing metal is gradually propagated throughout the mass without any extraneous heat.

APPLICATIONS.

Although this process is of comparatively recent invention, its applications are both numerous and varied; and it has now entered into current practice for welding metal parts, the repair of forged and cast objects, the making of complete spare parts, and the production of metals and alloys free from carbon. By the reaction of aluminium on the oxides this process also produces artificial corundum as a by-product; and Dr. Wolff lately proposed to apply it to the production of calcium carbide without employing the electric current.

PRINCIPAL ADVANTAGES.

1. The metals and alloys produced by this process are free from impurities, especially carbon, since that element does not enter into the reaction mixture. It is also asserted that they are almost free from aluminium, which circumstance is all the more remarkable because that substance is classed among the metals that can most readily be allied to others.

2. The inventor claims that, by employing suitable oxides, the highest possible temperatures may be obtained without cumbrous appliances, while, on the other hand, the sulphates afford the low temperatures that may be required for some applications.

3. It is possible to exactly determine beforehand, and within the widest limits, the heat to be given out by the reaction, its degree only depending on the nature and quantity of the substances present, and also to regulate the temperature obtained, that depends on the heat given out and the mass of matter over which it is distributed.

CONCLUSIONS.

These observations are contained in a communication to the *French Civil Engineers' Society* by M. H. Bertin, who went on to describe in detail the modes of practically applying the process, dealing *inter alia* with the substances to be employed, starting the reaction, casting, preparation of the metals and alloys, autogenous welding and welding with thermit, as also their advantages, and concluding that Dr. Goldschmidt's discovery is probably destined to take an important place in metallurgical practice.

SUPPRESSION OF BELTS FOR DRIVING DYNAMOS, ETC.

WITH an intermediate shaft for driving, the pulleys require frequent attention, while the belts, having indifferent adhesion, slip and sag, so that the efficiency is low; and, in the case of electric lighting, the light is inconstant, with the well-known disadvantages attending this defect. By suppressing the intermediate shaft, however, a constancy of light may be obtained that is otherwise only obtainable by the use of accumulators. Strangely enough, when the motor is a gas engine, the belts are relied upon to compensate for the irregularity of its working; and this compensation—the curing of one evil by another—has been characterised by Professor Witz as "mechanical homœopathy."

A simple and efficient method of driving, observed M. Defays, in a communication to the *Société Industrielle du Nord de la France*, is that devised by M. Denis, of Saint-Quentin, who employs friction pulleys of silicated cardboard, that have the great advantage of doing away with loose pulleys, owing to which belts are apt to slip off; and the success he obtained in driving turbines led him to extend the use of these cardboard pulleys to dynamos, fans, centrifugal pumps, etc. Thanks to the arrangement

of carriage on which the driving pulley is mounted, and which is fed up by screw and hand-wheel, both starting and stopping may be effected gradually and without shock.

In the case of a dynamo receiving its motion from a shaft, a cast-iron pulley on the latter is brought into contact with the silicated cardboard pulley on the dynamo shaft, plate springs being interposed to render shock impossible; and with this arrangement the speed can be increased without the use of belts or spur gear.

Hitherto only small powers have been transmitted by this method; but the author is of opinion that, if the lengths of contact be made proportional to the efforts, considerable powers may be transmitted. As a rule, a larger proportion of power is transmitted by friction pulleys than by belts of the same width and speed. M. Denis' dynamo, that was installed with intermediate shaft, had to run at 1,350 revolutions; but when friction pulleys were put in, the speed was reduced by 150 revolutions for the same voltage.

THE CARDBOARD PULLEY DIMENSIONS

are determined by the formula

$$l = 35\sqrt{\frac{e}{\pi n}},$$

l being the pulley's width, equal to its diameter; e the power to be transmitted, and n the number of revolutions, while the co-efficients were found by trial for powers up to 10 h.p., with speeds of 1,000 to 1,200 revolutions per minute.

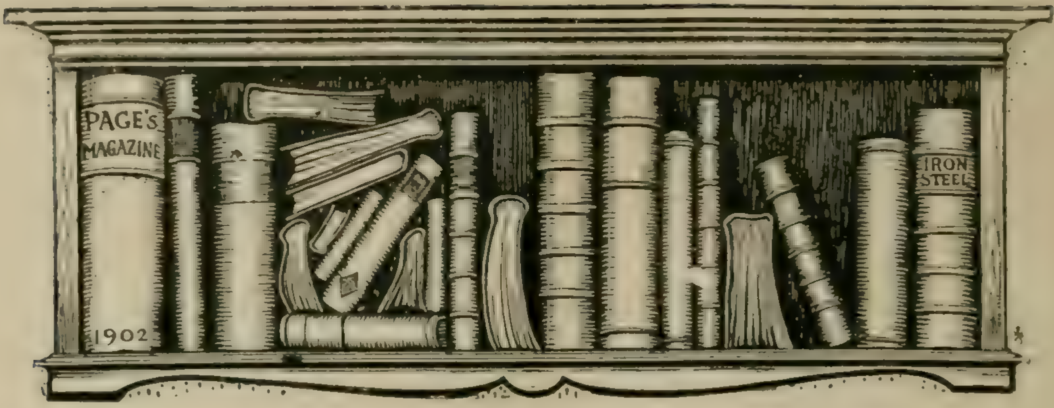
APPLICATIONS OF THE METHOD.

An application that at once suggests itself is that to reducing the speed given by steam turbines; and a centrifugal pump may be driven directly with great saving in first cost. At the Paris Exhibition of 1900 some Marinoni printing machines were driven directly at 80 revolutions by a dynamo making 1,200 revolutions per minute; and M. Denis has a fan that has been driven by his method for more than ten years, during which the friction cone has only been renewed once.

For driving a drilling machine at variable speed, friction cones of curved contour are used, one of them being canted so as to obtain contact at such a point as shall give the required speed, while the method is also applied to electric cranes and wood-working machinery.

THE NEW RUSSO-FINNISH ELECTRIC RAILWAY

THE St. Petersburg *Viedmosti* publishes details of the projected long-distance electric railway between St. Petersburg and the Fall of Imatra, in Finland. A concession has been granted for the building of an electric railway to the Finno-Russian frontier, but the Finnish Senate is now considering the petition of Mr. A. L. Von Knorring to continue this line for a total distance of 165 kilometres to Imatra. For the first 20 versts, to the village of Yokka, the line will be double, the remainder of the distance having a single line. The limit of speed is put at 78 kilometres an hour, or an average of 60 kilometres, including stoppages. This will enable the distance from St. Petersburg to Imatra to be covered in $2\frac{3}{4}$ hours. The local traffic between St. Petersburg and Yokka will be carried on in separate four-wheeled carriages, each equipped with an independent motor, and carrying thirty persons, while the long distance traffic will be carried on in eight-wheeled carriages, holding fifty persons each. On the shorter journey a carriage will be despatched every five minutes, and to Imatra one every hour. The goods traffic will be transported in similar separate waggons, but will be despatched only during the night. The estimated cost of the railway is put at 10,000,000 marks.



SOME BOOKS OF THE MONTH.

In this department special attention will be paid to all books dealing entirely or in part with subjects within the *purview of the Magazine*. While space will be given for expressions of opinion on books or papers of general interest which may be submitted for that purpose, contributors will please remember that this column is intended in the main for reviews of technical books dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining, and Allied Industries. The address of the publisher and prices should be enclosed in all publications sent for review.

"PLAIN FACTS AS TO THE TRUSTS AND THE TARIFF."

By George L. Bolen. Macmillan and Co. 451 pp. 6s. 6d.

THE author has succeeded in gathering together in the form of a readable volume many valuable facts concerning the present day trust and the operation of the American tariff. An attempt has been made to present the most salient points of the question in form suitable for the busy every day reader. Mr. Bolen commences with a brief sketch of the origin and purposes of trusts, and after discussing their varied possibilities for good and evil, he proceeds to describe the working of the various monopolies, with special reference to railways and municipal trading. Concerning the railroad problem in America, he says :—

> Is our railroad service perfect in every respect, needing no attention from the public? No, the agitation against it has been well grounded. The fault is not in efficiency of service, nor in average charges. It is in secret discrimination. As in the case of the oil company, railroads have built up one shipper by pulling down others, charging them higher rates, neglecting to furnish them cars, and delaying their shipments along the way. Through inequality of charges they have also built up some towns by checking the growth of others. Railroad discrimination has been the worst of all the forces of monopoly.

Government ownership is not regarded as the remedy, as the author thinks it would involve lower efficiency, slower improvement, and perhaps higher cost. He, therefore, advocates a continuation of the policy of regulating railway traffic by law. In another chapter we have further facts concerning the evils of railroad competition. An antidote to the rate-cutting which is carried to such a ruinous extent in the States, the writer is inclined to favour the system of permitting the formation of railway "pools," supervised by the Inter-State Commerce Commission, and subject to their approval.

> By this arrangement, rates and regulations could be kept reasonable to the public by the Commission, and every company could be held by the others to the pool contract by law. Instead of separate agencies, each lowering rates to get the business of large shippers, one joint office would answer for all the roads.

In conclusion, the author speculates as to the ultimate influence of the Trust *régime* on the public. There is no reason, he thinks, why capitalistic production, under public control of monopoly, should not continue to give society the best, cheapest and most rapidly improving supplies ; but he speaks out strongly against selfish and uncontrolled monopolies. On the other hand, he says, the trusts that are wanted

are those that hold their position solely by reason of surpassing excellence and cheapness of product.

These trusts are only too few, if they exist at all. But the club-wielding monopoly trusts, formed to squeeze customers, will discover that the people are not so helpless as they seem. Their power to restore just conditions will appear when they comprehend clearly what the monopoly trusts have undertaken to do. From the survey in these chapters of the trust situation, it does not seem that radical action will be necessary to dispose of them. Managers of trusts will realise quickly, perhaps with voluntary obedience to the public will, that now and hereafter, as always heretofore, private property and capitalistic production, to continue to exist unimpared, must prove to be the best system by service to society. Limiting the capital of corporations, and the kinds of business in which they may engage, as some economists have proposed, will apparently be postponed until the trust proves how far honest methods will maintain a monopoly.

In the second part of the book Mr. Bolen sketches the arguments for and against Protection, and adduces many facts in support of both theories. On the whole, the author may be said to have dealt with the subject in a fair and unbiassed manner, the work showing many evidences of keen insight and a conscientious study of the problems at issue.

"BRITAIN AT WORK."

A Pictorial Description of our National Industries. Cassell and Co. 4to. 384 pp. 12s.

IN this handsome volume the publishers have thrown open the doors of our national workshops and revealed to the reader the wonders of the nation's industrial life. In the course of fifty-nine fascinating articles, written in a popular style, we pass in review the battalions of Britain's workers, and visit the primary sources of her wealth and prosperity. Almost every variety of art and craft is described, and nearly every occupation portrayed, from the making of matches to the construction of an ironclad. The writers of the various articles have been assisted in their task by the photographer, who has supplied them with over 500 illustrations, finely reproduced by half-tone engraving.

Perhaps the most interesting sections are those devoted to the engineering and allied trades. The first of these, by Mr. H. W. Wilson, describes the building of a battleship, and we are able to watch its progress from the time of its laying down until it leaves the slip. A brief survey is given of the various yards and their specialities, including illustrations showing war vessels under construction in the yards of Sir W. G. Armstrong, Whitworth and Co., and the Thames Ironworks and Shipbuilding Company, Ltd. Another writer tells of Britain's underground wealth—of the collier's work in the mines and the transport of the fuel to the workshop and the fireside. The reader is then shown the processes involved in the production of iron and steel, illustrated by photographs taken in the Atlas Steel Works, the Yorkshire Steel and Iron Works, and the Cyclops Steel Works at Sheffield, and others. Further on we make the acquaintance of railway enginemen and their work, and get a glimpse of electric tramway systems, work in the great docks of London, Liverpool, and Southampton, needle and pin making in the Midlands, and the labours of the women nail and chain makers of the Black Country. Mr. R. W. Johnson contributes an article on the making of big guns, illustrated by photos of machinery in the works of Messrs. Vickers, Sons and Maxim, Sir W. G. Armstrong, Whitworth and Co., and Messrs. Cammell and Sons, of Sheffield. Mr. John Pendleton, who is responsible for several of the above-mentioned articles, also writes on the engineering industry generally, but he is obviously hampered by the limitations of space. There are illustrations of the Manchester Ship Canal, of bridges and cranes (by Messrs. Whitaker Bros., Ltd., of Leeds), the new floating dock at Bermuda, built by Messrs. Swan and Hunter, Ltd., and views in the works of Messrs. Mather and Platt, Ltd.

The book, which is a splendid example of the printers' art, is one of rare interest. It will be perused with pleasure by the technical reader, and its pages will convey to the general public a vivid impression of the sources of Britain's commercial greatness.

"AN OUTLINE OF THE METALLURGY OF IRON AND STEEL."

By A. Humboldt Sexton. Scientific Publishing Company, Manchester. 620 pp. 16s. net.

MR. SEXTON has set himself the task of gathering together in one work all the chief data connected with the metallurgy of

iron and steel, and has succeeded in outlining practically the whole field of theory and practice. The chapters on blast furnace work are especially instructive, indicating much research. A full description of the Bessemer and Siemens process is given, and a chapter devoted to special steels. The section anent the structure of iron and steel is of great interest, and includes some hitherto unpublished facts. The book is well illustrated, has an ample index, and a glossary of metallurgical terms. Much new and valuable information has been utilised, and the work forms a useful addition to the list of modern industrial text books.

A number of reviews are unavoidably held over this month owing to pressure upon our space.

NOTES AND NEWS.

The Korting Gas Engines.

By way of a supplement to the announcement in our October issue that Messrs. Fraser and Chalmers had secured the manufacturing rights for Korting Gas Engines used in connection with the steel industry, it should be mentioned that Messrs. Mather and Platt, Ltd., have secured the right of manufacturing these large gas engines for all other purposes outside the industry named.

This engine is of the double-acting two-cycle type, that is to say, each side of the piston receives an impulse at every revolution in contradistinction to the single-acting "Otto" cycle engine, which receives an impulse on one side of the piston only once in two revolutions.

The firm is taking up the manufacture of gas engines of large power more especially for driving dynamos, and as they also construct the latter, they are able to build the complete combined plant in their own workshops.

The Junior Engineers.

Our attention has been called to the excellent work that is being done by the Institution of Junior Engineers. The presidential address was delivered on November 21st by Colonel Edward Raban, C.B., R.E., on "The Preparation of Engineering Projects," and other noteworthy papers during the forthcoming session will include "Marine Boilers," a consideration of the relative values of the different types, by Mr. H. M. Routhwaite, M.I.Mech.E.; "Practical Notes on the Use and Maintenance of Electric Motors for Factory Purposes," by Mr. W. T. George; "Greasy Condensation Water as Boiler Feed," by Mr. William Paterson; and "The Effect of Design on Methods of Construction, from a Contractor's Point of View," by Mr. R. W. Newman, M.I.Mech.E. Between the meetings, visits to works and places of engineering interest in and near London take place at frequent intervals. A great deal of practical knowledge may thus be obtained, and this may be supplemented by borrowing books from the technical library. The Secretary is Mr. Walter T. Dunn, and the offices of the institution are at 39, Victoria-street, Westminster.

On the eve of going to press we have to record, with profound regret, the sudden death of Herr Friedrich Alfred Krupp, of Essen, from apoplexy, on the 22nd ult. Herr Krupp was only in his forty-ninth year, and his sudden demise has caused a profound sensation throughout Germany. The German Emperor addressed the following telegram to the directorate of the firm of Krupp at Essen:—

"The news of the unexpected death of your chief has been a great shock to me. Providence placed Geheimrath Krupp at the head of an enterprise which has achieved a universal significance far beyond the frontiers of the Fatherland. These works, inherited by him from that man of genius, his father, he regarded it as the business of his life not only to maintain but extend in accordance with their reputation throughout the world. His name is most intimately associated with the development of the iron industry and of the whole domain of armaments, including modern fortifications as well as naval construction. In his provisions for the well-being of those in his employment he was unsurpassed, and was a pattern to all. Thus I, to whom the departed was most loyally devoted in patriotic sentiment, share with the managing officials of his works and with the thousands of his workmen, the keenest sense of his loss.—William I.R."

Herr Krupp evinced a kindly interest in Page's Magazine from its foundation, and one of his last literary efforts was the revision of the article recently published on the Germania Ship-building Yard at Kiel.

S. HOWES, 64, MARK LANE, LONDON, E.C.

OWING to the virility of modern inventive genius, and the number of patents bidding for preference the choice of a turbine has become no easy matter. Those whose business it is to take advantage of water power and secure the best results in the least expensive way, may therefore welcome a few hints on the subject based upon actual experience.

Three points claim attention at the outset, viz., durability, economy in water, and highest efficiency. The prospective user of a turbine will find it desirable to determine whether the appliance under consideration is adapted to his special requirements, and it will also pay him to find out what others have done and are doing in similar circumstances.

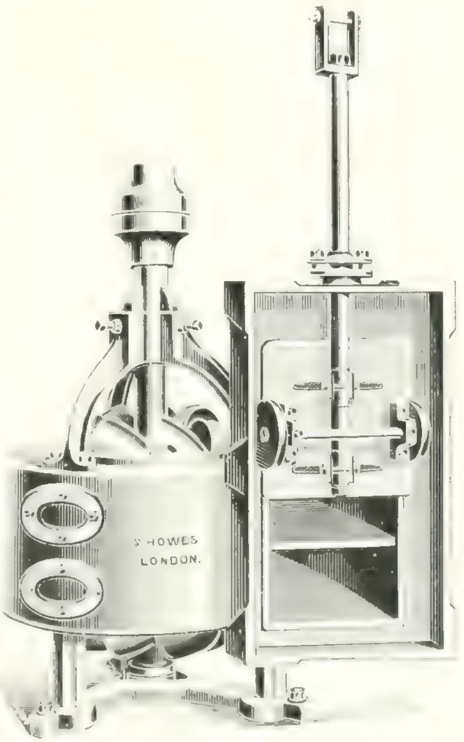
The inquirer is not likely to go very deeply into the matter before discovering that probably one of the largest orders for turbines ever executed, was given by the Canadian Government, who requisitioned no less than 253 of these appliances for use in operating the lock gates of the Welland Canal. This order was placed with Mr. S. Howes, of 64, Mark Lane, whose "Little Giant" Double Turbine held the field against all comers.

The turbine is mounted on a horizontal shaft for use when a direct drive is needed, thus dispensing with gears, etc., and making it particularly applicable for driving electrical machinery.

After the horizontal type had been placed on the market some time, the demand for it and the vertical double turbines was so great, that in order to meet the wants of all buyers it was found necessary to further increase the styles of the "Little Giant"; particularly for those wishing to develop power under low falls, and for this purpose the "Little Giant" was constructed in an improved case, and is now known as the "Special Flume" Wheel. This latter type is made up to 60 in. in diameter, so that as much as 36 horse power can be obtained under a 4 ft. head. Taking variations of size into consideration, the firm now make no less than 78 kinds of turbines.

Owing to its very high efficiency at part gate, it is suggested that the "Little Giant" Double Turbine can with advantage be applied in every case where there is considerable variation in the water supply, or where it is desirable that the water used should be in direct proportion to the power required. It is well adapted for situations where the water supply is often inadequate to drive the whole of the machinery, and where auxiliary steam power has to be used in dry weather, as it utilises the smallest quantity of water to the best advantage. In the majority of cases the water in winter and summer is variable; not only this, but the head is often reduced by backwater, etc. These and other reasons show why a turbine should give the highest possible efficiency at part gate. The "Little Giant" is a double turbine having two tiers of buckets, or strictly speaking, two turbines, keyed to the same shaft, one above the other, and both running in the same case, the upper tier discharging at the top, and the lower one under the bottom of the case.

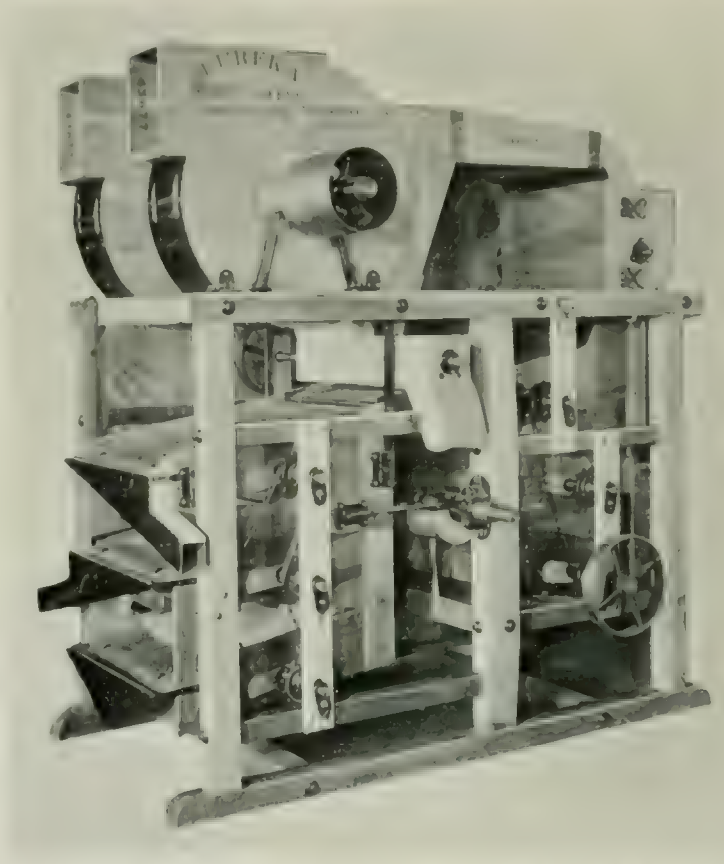
By using this special shape of bucket, curving as it does towards the stream, the water has a steady



"LITTLE GIANT" DOUBLE WATER TURBINE—VERTICAL TYPE.

unbroken flow from the time it enters until it is discharged from the wheel. The water entering the wheel with a greater velocity than that at which the wheel is moving, imparts to it a greater force, and the design of the bucket where the water first strikes it, is such that the water moves in the same direction as the wheel; therefore the friction of water against the bucket at this point is helping instead of retarding the wheel: hence we have an important advantage over other turbines where the friction acts in the opposite direction to the motion of the wheel.

The shaft (to which the buckets or wheel is keyed) is supported at the bottom end and revolves upon an adjustable lignum-vitæ step in the bottom bridgetree. The case (or guide) is made of iron in the form of a scroll. The cases for all wheels up to *twenty-four inches in diameter*, are cast in one piece. The case for larger sizes is made of boiler plate, the edges of which are planed parallel. This is held between the cast iron top and bottom plates by bolts. The case is supported by the bottom bridgetree, which is bolted firmly to it. The bridgetree is fastened to the bottom of the wheel pit, upon which it rests by "Lewis" or "Rag" bolts. The gate box is made of cast iron, and bolted to the case. The gate or sluice is also made of cast iron, the surface of which, as also the ways or seat upon which it slides, are planed, thus forming a perfectly water-tight joint. The pressure of water always holds the gate to its place, and the joint remains tight as the gate wears. The gates for the larger sizes of turbines, particularly if to be used under high heads, are mounted upon friction rollers (as shown in the first cut), which changes the friction from sliding to rolling, making the gate more easily operated.



"EUREKA" COFFEE, RICE, AND SEED SEPARATOR, GRADER, AND CLEANER.

There are two hand-holes in the case, fitted with water-tight caps, which may be readily opened to remove any obstruction that may get into the wheel. The convenience of this will be best appreciated by those who have been obliged to lose valuable time in stopping their mills to draw the water from their flume, in order to take the wheel apart and remove some obstruction that could have been taken out of our turbine in a few minutes without dissecting it or disturbing the head-gates.

The upper bridgetree, which is bolted firmly to the top of case, is made of cast iron, and of sufficient strength to prevent any springing of shaft.

The bearing or stuffing box in the upper bridgetree for shaft is bushed with lignum-vitæ, and is adjustable so that the turbine may at all times be held in the centre of case, thus preventing leakage and loss of power caused by the friction of the wheel rubbing against the case.

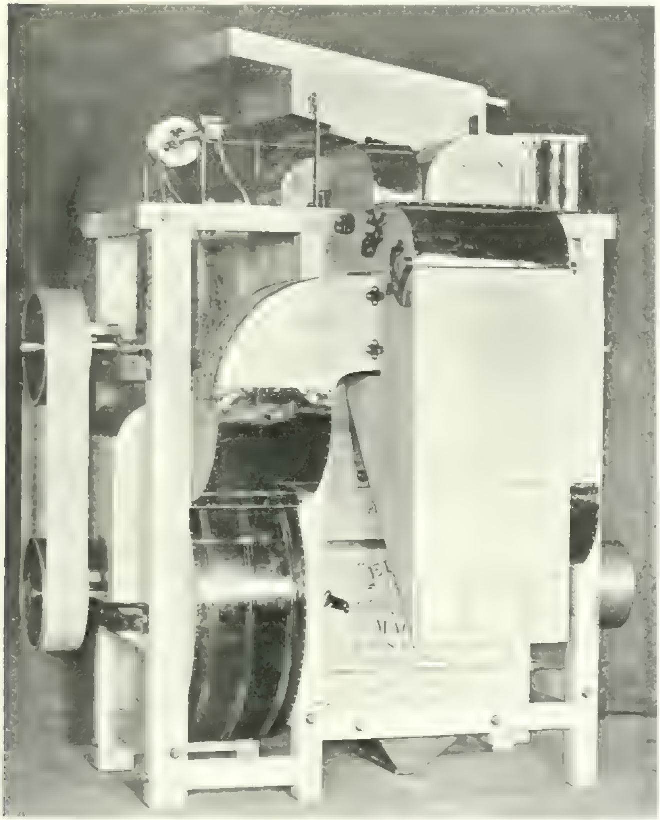
S. Howes, 64, Mark Lane, E.C.

Full information is offered to inquirers who are anxious to adapt the turbine to their special needs. The following questions should be carefully considered by prospective users :—

What is the head of water when at rest, or the vertical distance from surface of head-water to surface of tail-water ?

If the stream is small, what quantity of water can be relied upon ? If the water supply is variable, state how much it varies in wet and dry seasons ; or if an overshot is used, state the diameter and width, and how much the gate was raised to let the water on, and particularly how deep the water was above the gate opening in the forebay.

If the stream is large, state width of same, or, if possible, give us a measurement according to our scheme of instructions for " large open streams."



" EUREKA " BOTZ WHEAT AND BARLEY SCOURING AND BRUSH MACHINE

What size and make of turbine, if any, is at present, or has been, running ; and how many square inches gate opening is there in the wheel and how many hours out of twenty-four will the stream afford sufficient water to supply it ?

What kind of machinery is to be driven ?

Give speed of line shaft, and the direction in which it turns.

Give the vertical distance of line shaft from head or tail-water level, and also its distance from the mill floor.

Another speciality of the firm is the " Eureka " wheat, coffee, rice, seed and malt-cleaning, grading, hulling and separating machinery. The accompanying illustrations show two types of over three hundred and fifty manufactured.

The term " Eureka," as applied to milling, grain-cleaning, and elevator machinery, is significant. The extensive range of machinery manufactured under this name had its origin in the early fifties, when, at Silver Creek, N.Y., on Lake Erie, Simeon Howes erected a small plant for the production of his " Smutter." The business owes its present development very largely to Mr. Louis E. Barbeau, who for some years has personally dictated the fortunes of the European branch.

" Eureka " rice graders, hullers, polishers, etc., are now in nearly all the large rice mills of the country. Coffee, also, is being treated with a line of special " Eureka " machines ; and even peanuts are manipulated through all the varying processes of manufacture from the picking of the nuts, etc., to the reduction of the shuck into a powdered form, by " Eureka " machinery. It is not surprising that the original number of distinct models and types of " Eureka " machines is still on the increase, and that Mr. Barbeau has been called upon to supply his machinery in every part of the world.

The firm are also manufacturing a complete line of portable and stationary forges, and hand and power drills.

CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention PAGE'S MAGAZINE when you write. Manufacturers of Engineering and Electrical Specialities, etc., etc., are invited to forward, for review in this column, copies of their catalogues, price lists, and circulars, as soon as issued.

Blumann and Stern, Ltd., Plough Bridge, Deptford, London. Calendar for 1903 printed in two colours, with separate sheet for each month. The reverse of each leaflet is utilised either as a price list or for descriptions of the firm's specialities, which consist of lubricating oils of all kinds, tallows and greases, etc. A reprint from a recent issue of the *Railway Supplies Journal* is particularly interesting as proving the excellence of the lubricants manufactured by this firm. It is pointed out that during the trials of H.M.S. *Viper*, when the engines developed 12,000 i.h.p., and the mean speed for the six runs showed 36·581 knots, or a velocity equivalent to 43 miles an hour, the lubricants employed throughout were supplied by Messrs. Blumann and Stern.

The Unbreakable Pulley and Mill Gearing Co., Ltd., Manchester and London.—A Treatise on the Economical Transmission of Power. Tenth Edition. 2s. 6d. post free. In the introductory chapter the writers draw attention to the fact that it is not sufficiently realised how important a part the machinery used for the transmission of power has in the general economy of manufacturing establishments, and endeavour to show that a saving of 5 per cent. on the yearly coal bill can be effected. The sometime prejudice, we are told, against the use of cast iron for bearings has practically disappeared, and there is now scarcely a large engineering firm in the kingdom which has not adopted these bearings to a greater or less extent. The authors add : "Any power consumed by shafting beyond the small amount necessary to overcome friction in well designed, truly erected, and properly lubricated bearings, is absolutely wasted ; yet, though people will look closely enough into the economy of the engine or machines they are going to buy, economy in the means by which power is transmitted from the engine to the machines is constantly overlooked, generally also the economy in erection, while the sole care is to buy from the man who will supply so many feet of shafting and so many bearings at the lowest price." The main object of the work, we gather, is to set out as concisely as possible the rules upon which an engineer should work in arranging a system of [illegible] for a factory, with full tables of strengths, weights, powers, and velocities, so that the book may serve as a handy reference for the skilled designer, and a trustworthy guide for those who have no special knowledge of the subject, but who desire to plan their own arrangements. We certainly think it is a valuable work [illegible] of the above points. The subject matter is suitably arranged [illegible]. A [illegible] half-tone illustrations and woodcuts leaves little to be desired.

William Ryder, Ltd., Bolton, Lancs. Illustrated Catalogue of Forging Machines, Sawing Machines, and other tools, with prices. The booklet, which is printed in two colours, is well designed, and is illustrated by means of some excellent wood cuts. The principal speciality is the now well-known Forging Machine, made in various designs with three to five pairs of steel blocks, or hammers, and in weight varying from 25 cwt. to 5 tons. The sawing machines, which are very frequently used in the smithy in conjunction with forging machines, are made in various sizes and weights, and with sawing capacities for hot iron bars varying in thicknesses from 3 to 6 in.

The Clyde Structural Iron Company, Ltd., of Scotstoun, Glasgow. A neat little booklet of forty pages and cover, comprising a catalogue of structural iron and steel work as manufactured and erected by the company. The illustrations include some interesting designs for curved roofs, agricultural sheds, stores, granaries, dock sheds, market place or bazaar, drill and public halls, swimming baths, tea factories, gold mine buildings, engineering shops, bungalows, bridges, etc., etc. With regard to the photographs of recent work carried out by the firm, we quite agree with their remarks, that these serve better than any quantity of letterpress to indicate the kind of work they are prepared to execute. They include excellent examples of railway, foundry, and other work.

Graham, Morton and Co., Ltd., Leeds.—A neat little brochure of fifty-two pages and cover, entitled "Elevating and Conveying Machinery," being a description, with numerous illustrations of an economic method of transportation of coal and minerals. The system consists of a plant by means of which coal or other material is automatically conveyed from one given point to another, thus saving, it is claimed, 80 per cent. of labour cost. The illustrations include reproductions from photographs of (1) a plant to handle coal and store it in coal stores at the rate of 30 tons per hour ; (2) an elevating plant at the generating station of the Leeds City Tramways, which conveys coal from boat to boiler furnace at a total labour cost of 1d. per ton ; (3) a plant erected to weigh, handle, and store coal at the rate of 40 tons per hour ; (4) a large conveyor, over 400 ft. long, erected for carrying 150 tons of coal per hour ; (5) conveying plant erected for feeding a water-tube boiler and a series of Lancashire boilers. The coal is brought automatically from the coal stores by means of continuous conveyors, and (6) a conveyor which carries sacks of flour at the rate of 1,000 per hour. Other illustrations show screening, measuring, and weighing plants, belt conveyors, storage bunkers, a novel coal-tipping apparatus—by means of which a railway truck can be automatically tipped and emptied at once—spiral conveyors, etc., etc.

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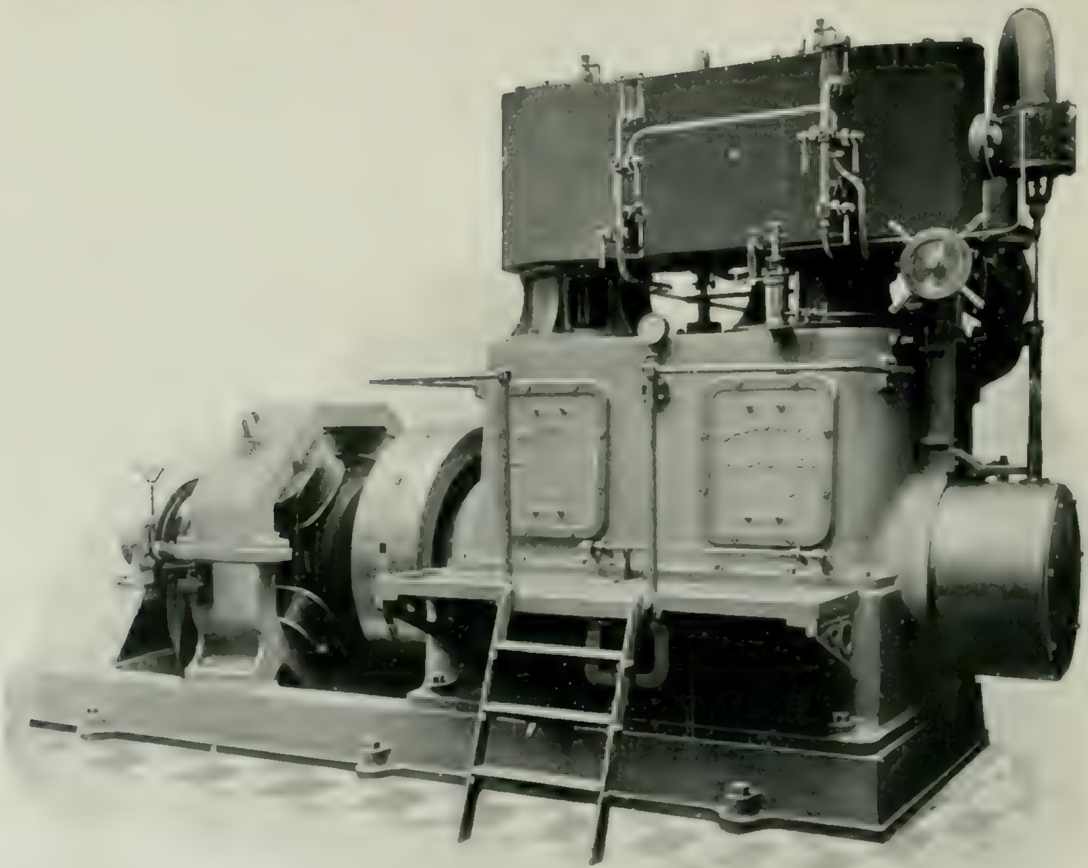

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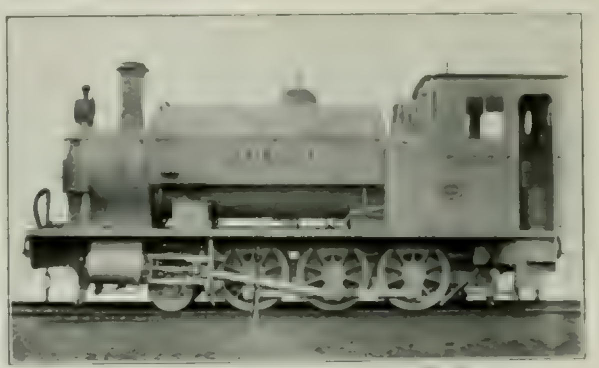

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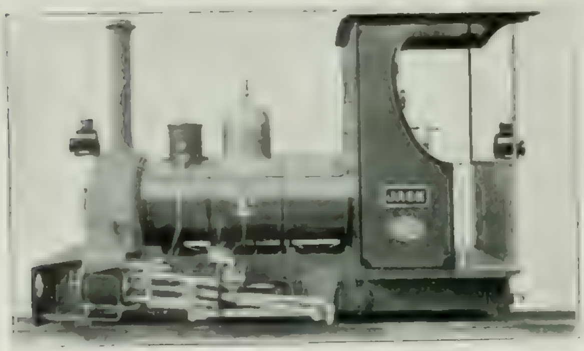

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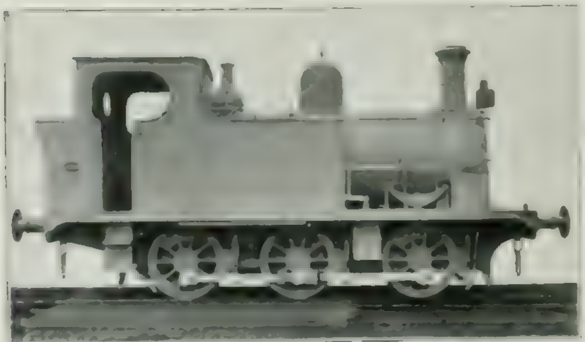

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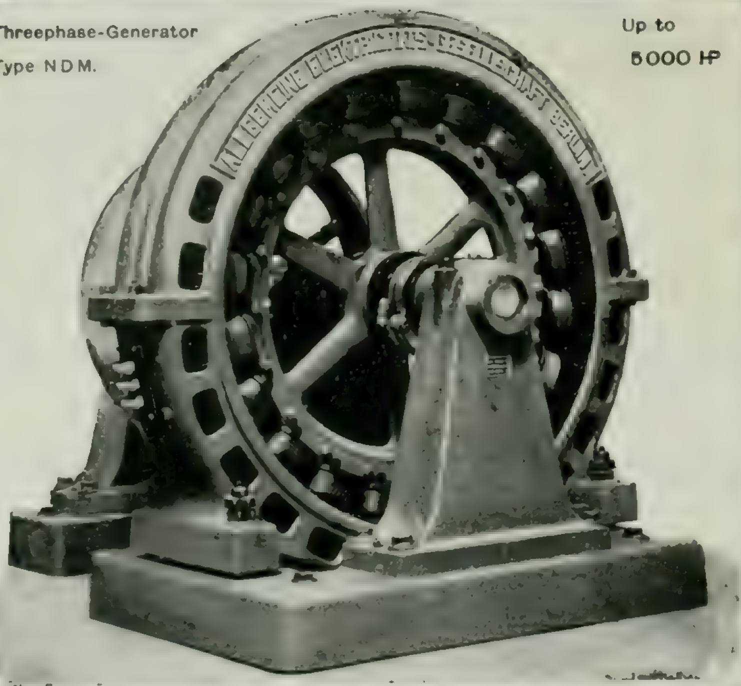

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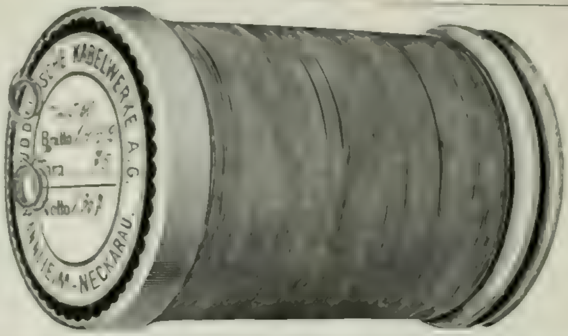

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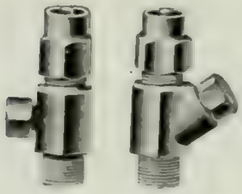

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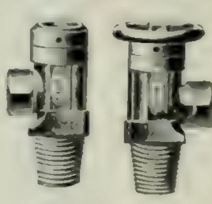

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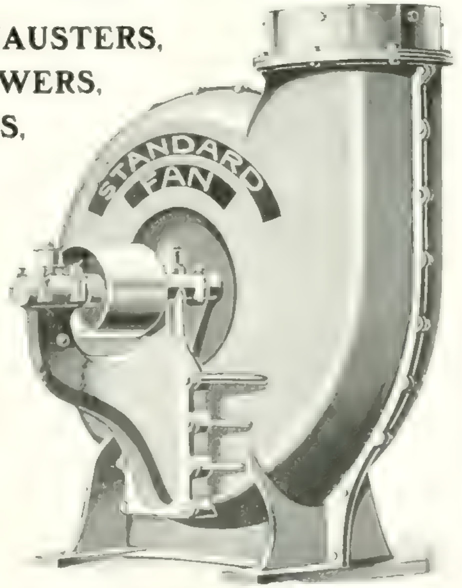

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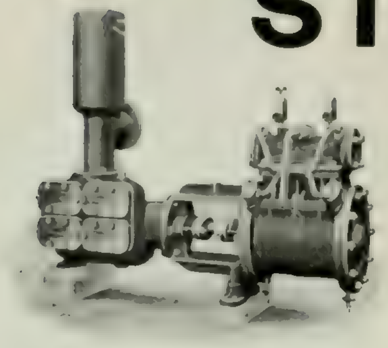

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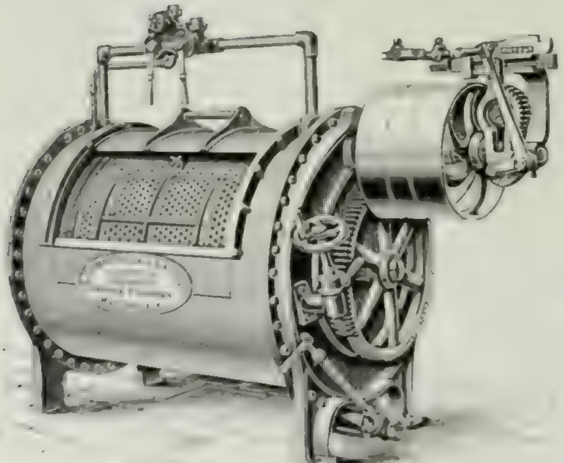

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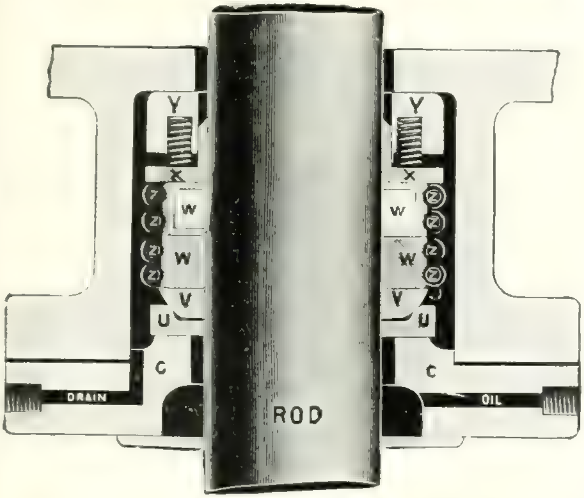

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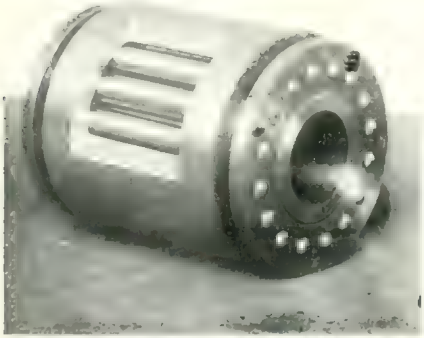

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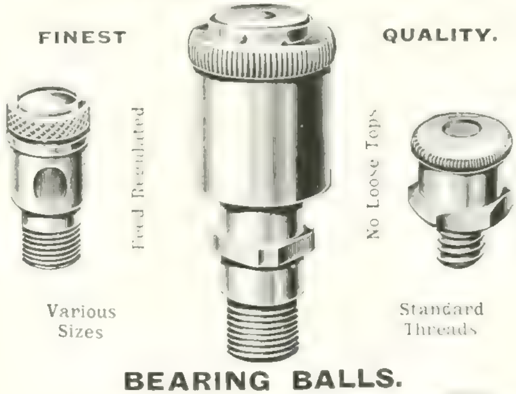

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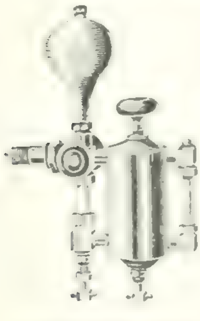

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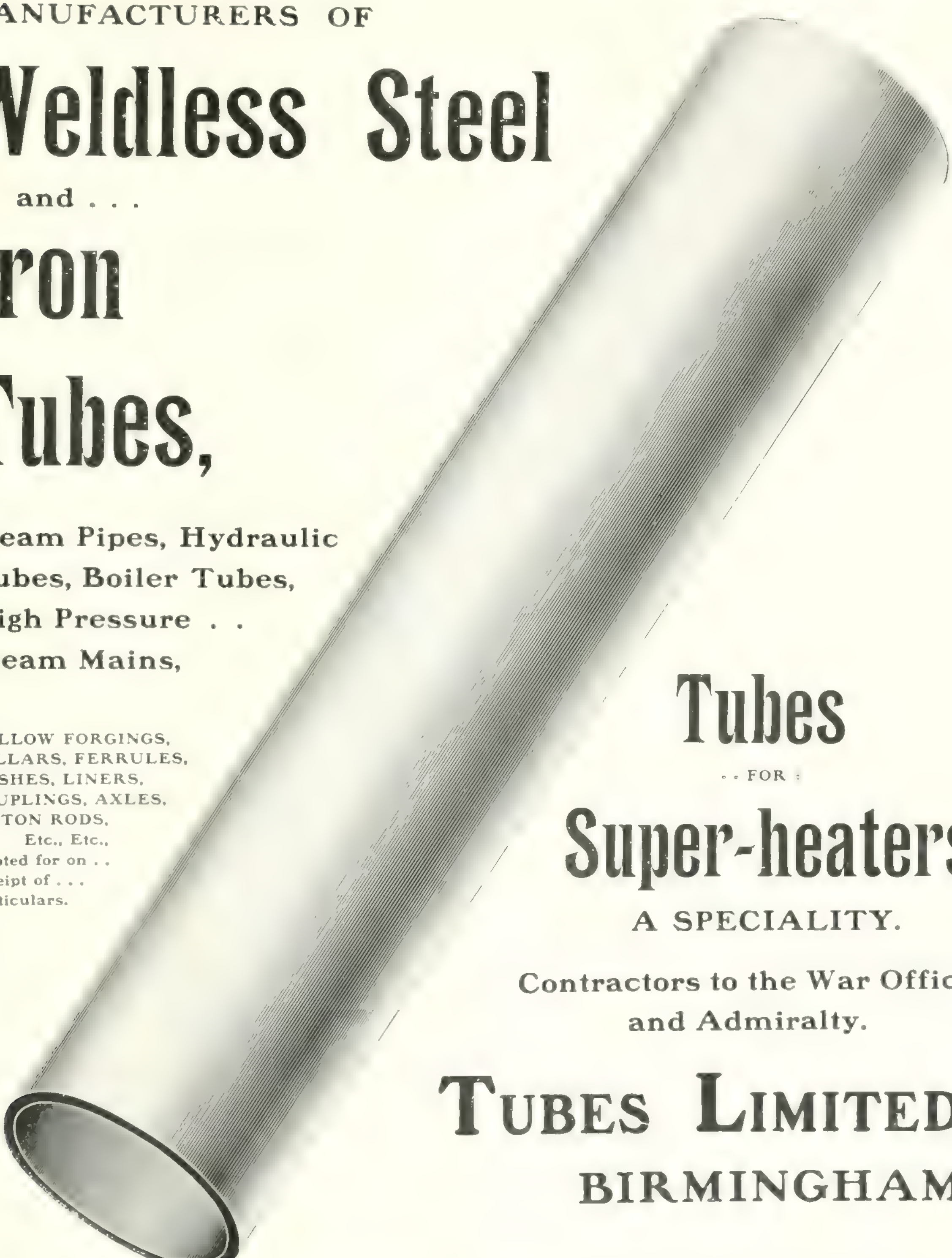

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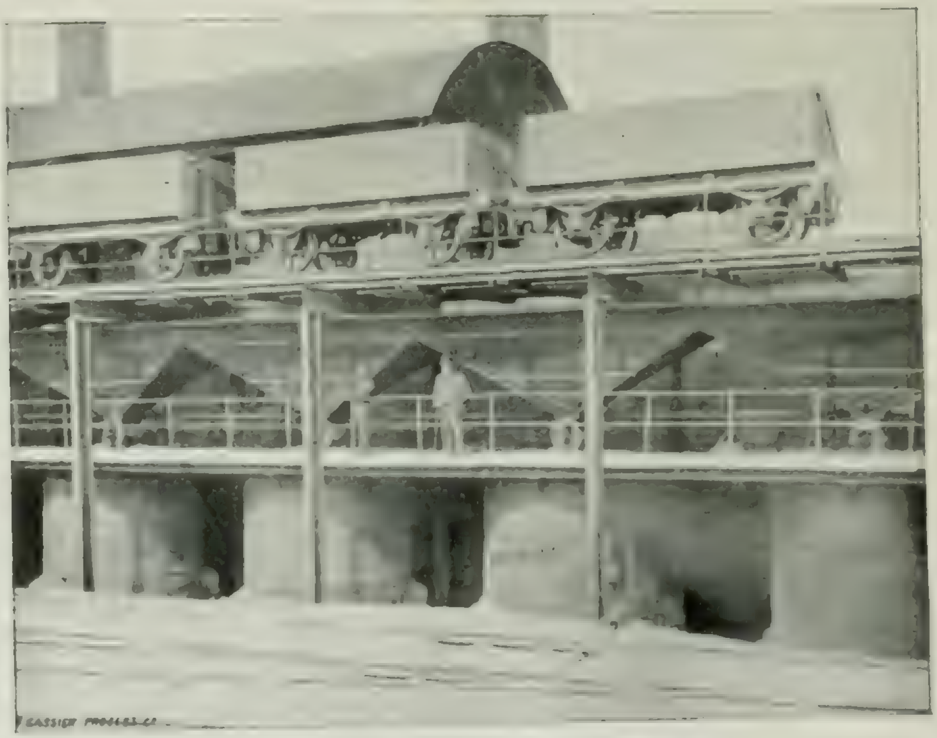

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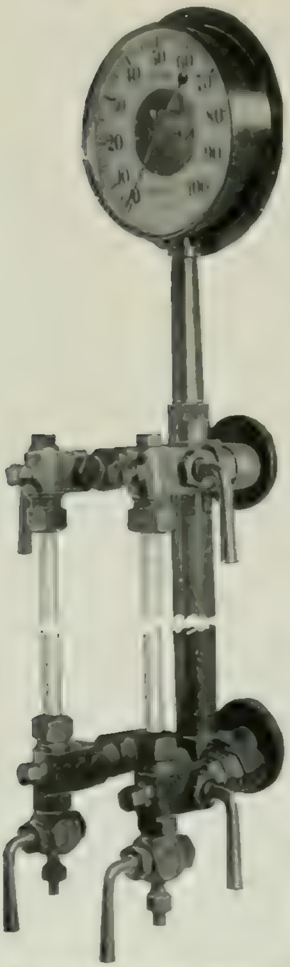

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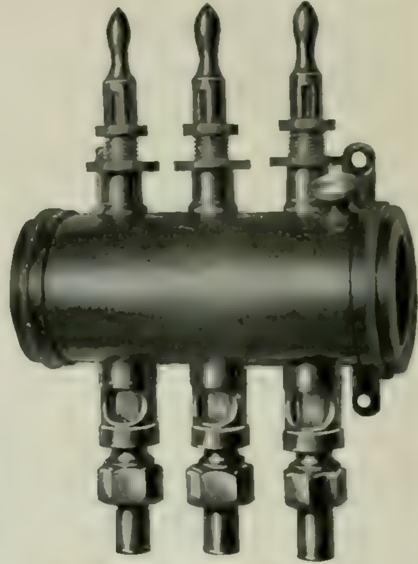

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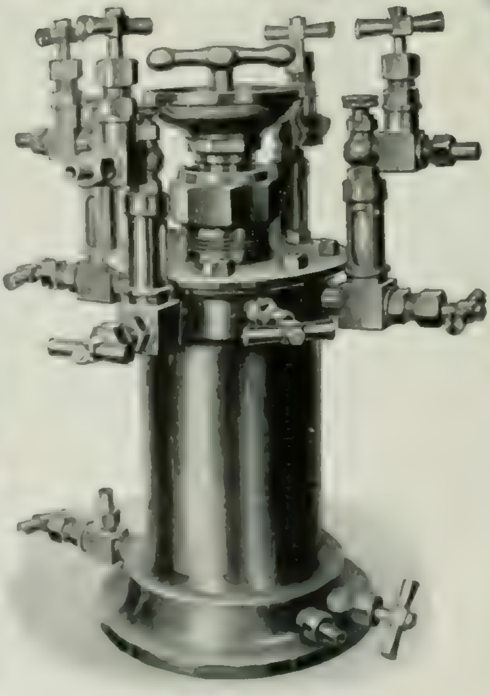

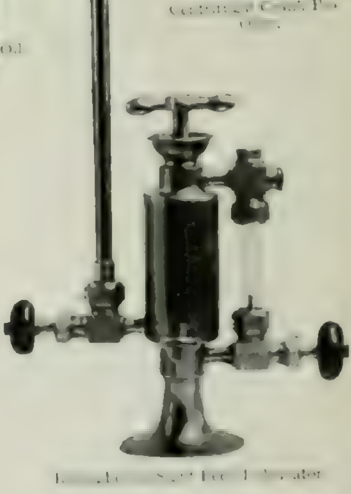

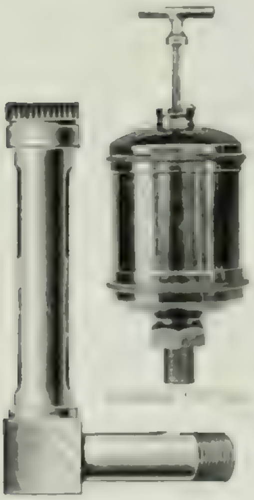

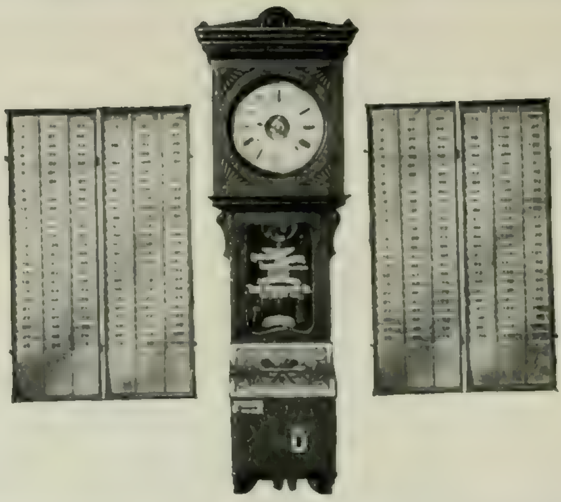

This illustration represents a few of the many thousands of workpeople whose time is daily recorded on the "Dey."

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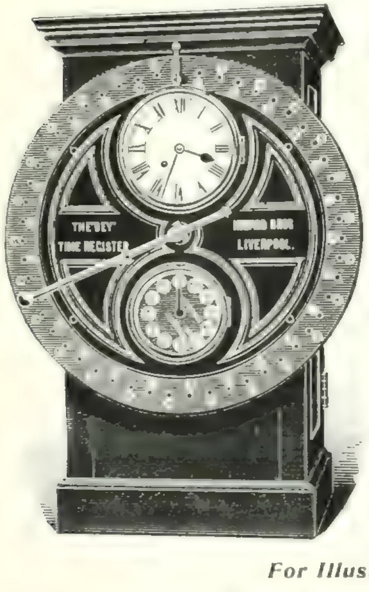

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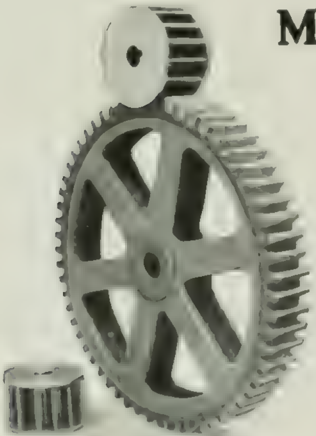

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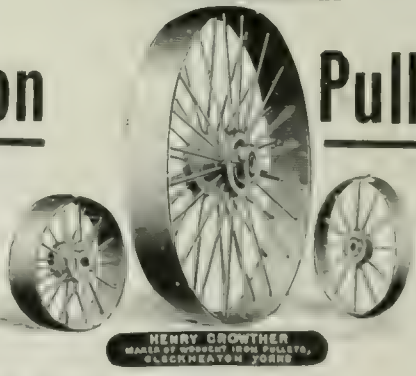

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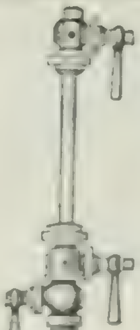

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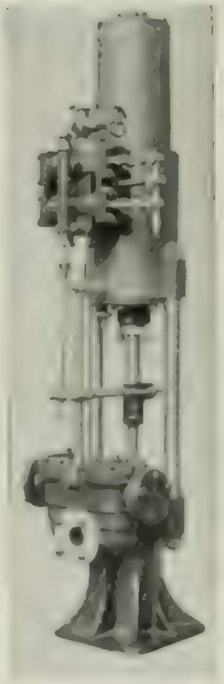

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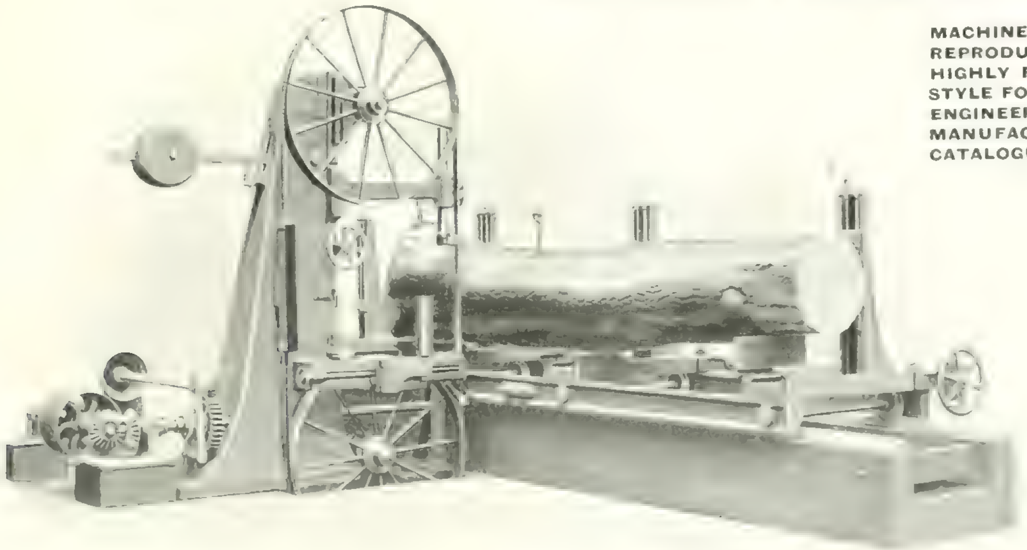

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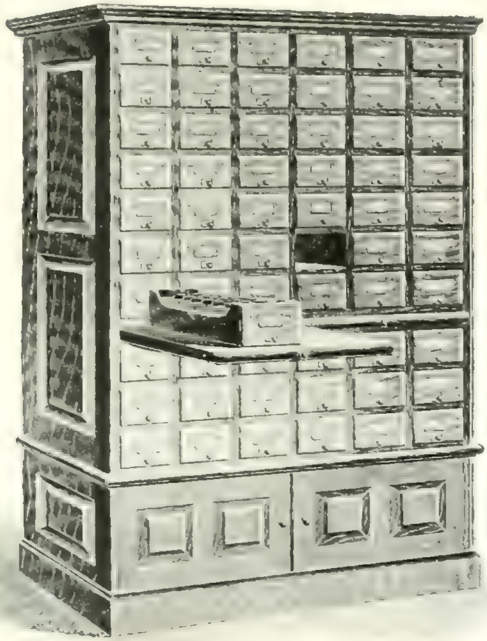

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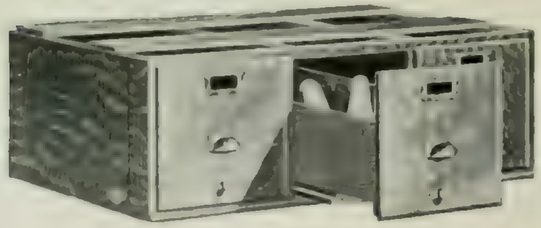
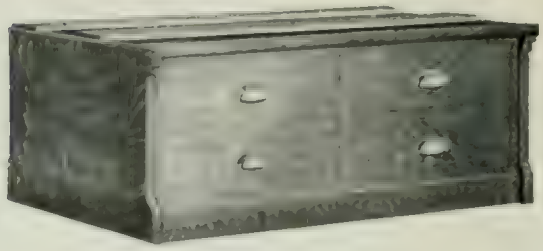
Card Index Section.
5 by 3 Cards.

No. 64.
Card Index Section.
6 by 4 Cards.

No. 85.
Card Index Section.
8 by 5 Cards.



No. 20.
Vertical Filing Section.



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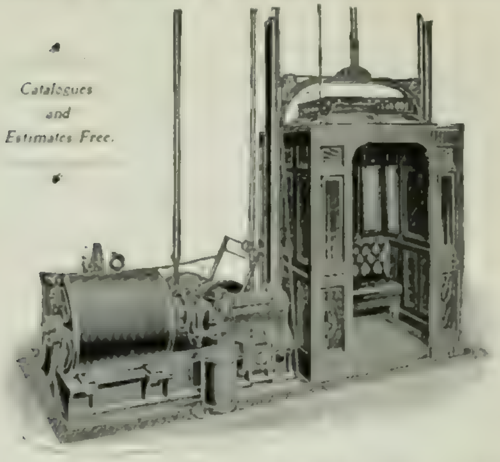

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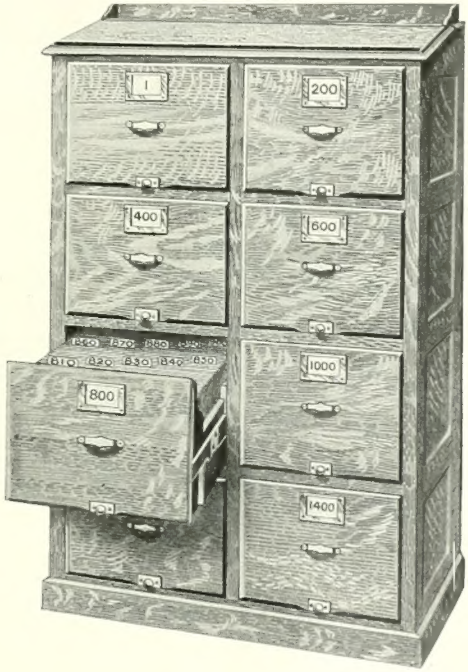
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